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UNDERSEA WARFARE

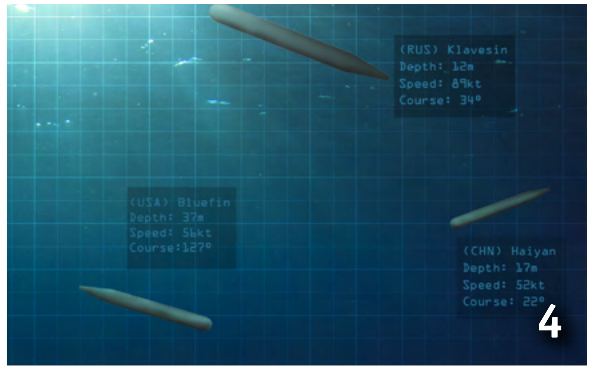
U. S. SUBMARINES... BECAUSE STEALTH MATTERS

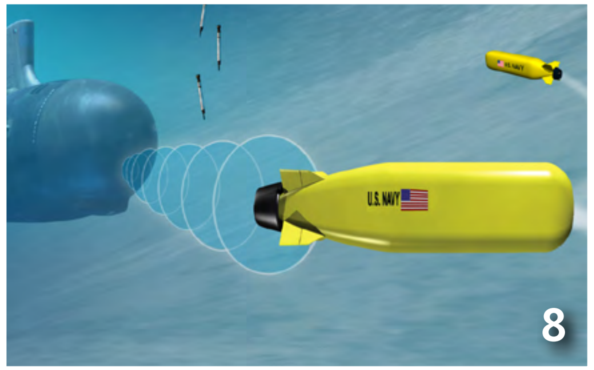
UUV's

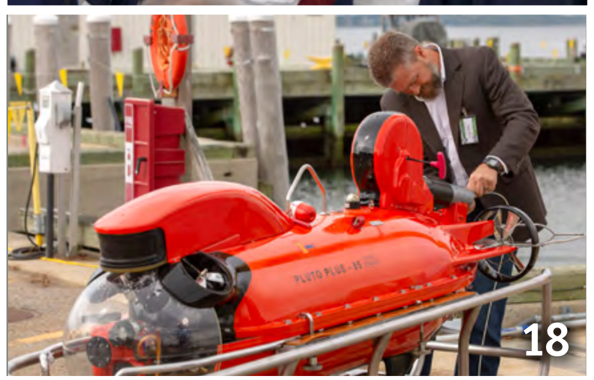
Persistent Presence and Payload Capacity

Spring 2019

Issue No. 67







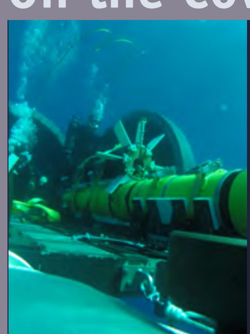
UNDERSEAWARFARE

THE OFFICIAL MAGAZINE OF THE U.S. SUBMARINE FORCE

UUV's

Persistent Presence and Payload Capacity

On the Cover



A U.S. Navy diver readys a UUV for testing operations from a dry deck shelter onboard an SSGN.

Photo by Mass Communication Specialist 1st Class Ronald Gutridge

Departments

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FORCE COMMANDER'S CORNER

Vice Adm. Charles A. Richard, USN
Commander, Submarine Forces

Undersea Warriors,

Greetings from Norfolk! In the last edition of *UNDERSEA WARFARE Magazine*, I talked about instilling a warfighting culture in everything we do. We have made great progress and I want to take a few minutes to get everyone up to speed with where we are now and ensure that we are all aligned on where we are headed.

One of the best ways to enhance crew warfighting readiness and drive innovation is through competition. So we have moved out to ensure a driving objective of our training is to compete to win. Submarine Learning Center is leading the effort and school house COs are serving as local umpires. We will have individual and team competitions ranging from visual recognition and sonar classification to fire control tracking parties going head-to-head against one another at sea or in linked trainers. We will publish winners and losers in message traffic and we will track which crews are the best and which ones are the worst. Other ideas are under consideration, such as custom tabs for the left-hand pocket on NWU-type IIIs. Will your boat make the Final Four?

"One of the best ways to enhance crew warfighting readiness and drive innovation is through competition. So we have moved out to ensure a driving objective of our training is to compete and win."

To increase lethality across the Force, we have identified the initial Aggressor Squadron CO, and Aggressor Squadron is on track for an April 2019 initial operational capability. Its goal is to employ an effective cadre of experts (red team) versed in opposition warfighting philosophy, strategy, and tactics to stress submarine crews in warfighting scenarios. Red team expertise will be available locally or virtually to support training and certification. Additionally, we are working on connectivity between attack center locations to allow remote red team engagement, and we are exploring the possibility of employing select SSN(s) as a standing red opposition force for live at-sea play. This will take some time to reach full operational capability, but we're moving out! To quote an old movie "The clock is running…and we're keeping score."

There are a number of other classified warfighting initiatives happening right now that Rear Adm. Converse and I are very excited about. We will push those out to the Fleet soon via the "Fight Club" brief, which we will update monthly.

Our Force is made up of the most innovative and talented people in the country, and Rear Adm. Converse and I would like to tap into your ideas. If you've got an idea on how we can do business better across the Submarine Force, we want to hear from you. Whether it's a technological breakthrough that you think would revolutionize undersea warfare or a process improvement that you think every ship should use, let us know. Send your ideas to HeySUBFOR@navy.mil and help us to help you.

This month the theme for *UNDERSEA WARFARE Magazine* is Unmanned Underwater Vehicles (UUVs). There is no question that dominance in the undersea domain will require a family of unmanned systems capable of conducting a variety of missions. Most of us are familiar with "dull, dirty, and dangerous" missions that we usually associate with UUVs, but I'd like to expand that mission set to "dull, dirty, dangerous, or otherwise impossible," and let's start with the otherwise impossible part. In this edition, you will get a look at UUVs in action today, get an overview of our medium- to long-term UUV strategy, and get an update on the UUVRON 1 one-year anniversary. UUVRON 2 will follow shortly.

It's truly an awesome time to be an undersea warrior!

Prepare for battle.

Our nation needs you.

AAIII!

C. A. Richard

DIVISION DIRECTOR'S CORNER

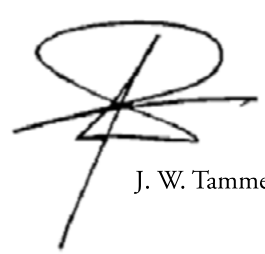
Rear Adm. John W. Tammen, Jr., USN
Director, Undersea Warfare Division

Undersea Warriors,

In the last issue, I stressed the need to accelerate next-generation capabilities to the warfighter to maintain our margin on undersea superiority. Attack submarines are critical enablers of the National Defense Strategy and represent one of the nation's most lethal asymmetric advantages. It is critical that we maintain our undersea advantage and remain versatile in an unpredictable environment. We need to be able to create scalable effects to complicate our adversaries' calculus. The Subsea and Seabed Warfare Initial Capabilities Document was recently approved and provides the framework through which we incorporate new capabilities that extend the submarine's reach to very deep and very shallow areas where we have limited influence today. The Initial Capabilities Document is just the first step, bringing scalable effects to the seabed and undersea domain. Our first step is getting Unmanned Underwater Vehicles (UUVs) in the hands of the operators at scale. My goal is to get small and medium UUV launch and recovery from torpedo tubes on par with that of towed array deployment and retrieval.

"It is critical that we maintain our undersea advantage and remain versatile in and unpredictable environment."

The days of UUV operations being a niche mission are over. We will continue to develop and deliver a sustainable inventory of all classes of UUVs, with adequate inventory, proper manning and training for employment, and Fleet systems to enhance our reach and lethality throughout the undersea domain. The technology still needs to mature, but UWDC, the TYCOMS, and N97 are aligned to get the warfighters the CONOPS and capability in the near term. UUVs are a different challenge than UAVs; there is no man in the loop and they need to be 100% autonomous. They are truly on independent ops. Set/drift, prevention of mutual interference, and underwater navigation are challenging for manned submarines and will be much more difficult without an operator. However, I am convinced we can solve these challenges with our collective efforts.



J. W. Tammen, Jr.

UNDERSEA WARFARE

The Official Magazine of the U.S. Submarine Force

Vice Adm. Charles A. "Chas" Richard
Commander, Submarine Forces
Commander, Submarine Force Atlantic

Rear Adm. Blake Converse
Deputy Commander, Submarine Forces
Commander, Submarine Force U.S. Pacific Fleet

Rear Adm. John W. Tammen, Jr.
Director, Undersea Warfare Division (N97)

Master Chief Petty Officer John J. Perryman
COMSUBLANT Force Master Chief

Master Chief Petty Officer Paul J. Davenport
COMSUBPAC Force Master Chief

Cmdr. Sarah Self-Kyler
COMSUBLANT Public Affairs Officer

Cmdr. Cynthia (Cindy) Fields
COMSUBPAC Public Affairs Officer

Military Editor: **Lt. Cmdr. P. Brent Shrader**
Senior Editor, Design & Layout: **Rick Johnston**
Managing Editor: **Thomas Lee**

Charter

UNDERSEA WARFARE is the professional magazine of the undersea warfare community. Its purpose is to educate its readers on undersea warfare missions and programs, with a particular focus on U.S. submarines. This journal will also draw upon the Submarine Force's rich historical legacy to instill a sense of pride and professionalism among community members and to enhance reader awareness of the increasing relevance of undersea warfare for our nation's defense.

The opinions and assertions herein are the personal views of the authors and do not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy.

Contributions and Feedback Welcome

Send articles, photographs (min. 300 dpi electronic), and feedback to:

Military Editor, Undersea Warfare CNO N97
2000 Navy Pentagon, Washington, DC 20350-2000
E-Mail: underseawarfare@hotmail.com
Phone: (703) 614-9372 **Fax:** (703) 695-9247

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CHINFO Merit Award Winner

Silver Inkwell Award Winner

LETTERS TO THE EDITOR

In keeping with *UNDERSEA WARFARE* Magazine's charter as the Official Magazine of the U.S. Submarine Force, we welcome letters to the editor, questions relating to articles that have appeared in previous issues, and insights and "lessons learned" from the fleet.

UNDERSEA WARFARE Magazine reserves the right to edit submissions for length, clarity, and accuracy. All submissions become the property of *UNDERSEA WARFARE* Magazine and may be published in all media.

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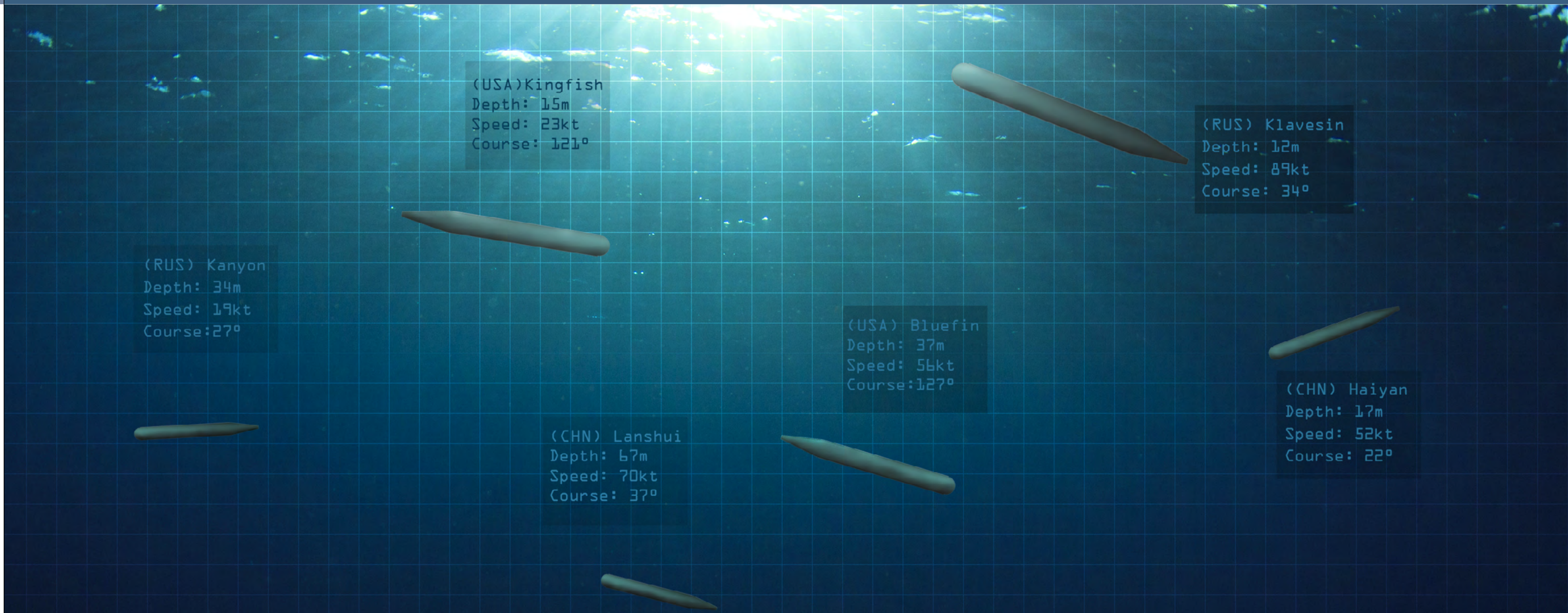
★ MEDAL OF HONOR MOMENT ★

Cmdr. Eugene Fluckey

COMMANDING OFFICER USS *BARB*

For conspicuous gallantry and intrepidity at the risk of his life above and beyond the call of duty as commanding officer of the U.S.S. *Barb* during her 11th war patrol along the east coast of China from December 19, 1944 to February 15, 1945. After sinking a large enemy ammunition ship and damaging additional tonnage during a running two-hour night battle on January 8, Cmdr. Fluckey, in an exceptional feat of brilliant deduction and bold tracking on January 25, located a concentration of more than 30 enemy ships in the lower reaches of Nankuan Chiang (Mamkwan Harbor). Fully aware that a safe retirement would necessitate an hour's run at full speed through the uncharted, mined, and rock-obstructed waters, he bravely ordered, "Battle station—torpedoes!" In a daring penetration of the heavy enemy screen and, riding in five fathoms of water, launched the *Barb*'s last forward torpedoes at 3,000-yard range. Quickly bringing the ship's stern tubes to bear, he turned loose four more torpedoes into the enemy, obtaining eight direct hits on six of the main targets to explode a large ammunition ship and cause inestimable damage by the resultant flying shells and other pyrotechnics. Clearing the treacherous area at high speed, he brought the *Barb* through to safety, and four days later he sank a large Japanese freighter to complete a record of heroic combat achievement, reflecting the highest credit upon Cmdr. Fluckey, his gallant officers and men, and the U.S. Naval Service.

by Capt. Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406)



NAVY UNMANNED UNDERWATER SYSTEMS:

AN OVERVIEW

Today the Navy is challenged to maintain undersea superiority in an era marked by the return to great power competition. The National Defense Strategy clearly lays out why the military services must readily adapt to meet the emerging demands imposed by this new competition with China and Russia. The strategy also warns that America's military cannot hope to prevail in future conflict "using yesterday's weapons or equipment."

The strategic goal of the Navy is to ensure access to the maritime environment for all countries. In support of this goal, the Navy is using and plans to use Unmanned Undersea Vehicles (UUVs) to conduct the "dull, dirty, dangerous, or otherwise impossible" missions to complement, enhance, and enable existing missions as well as perform the emerging missions of Subsea and Seabed Warfare (SSW), Electromagnetic Maneuver Warfare (EMMW), and non-kinetic Sea Control.

Unmanned systems stand at the forefront of a new evolution in military technology that includes advances in artificial intelligence, autonomy, target recognition, endurance, and payloads that will play a critical role in extending the reach, capability, and capacity of manned fleet assets. It is no longer a question of whether unmanned vehicles will provide operational value to the fleet, but rather how quickly these new capabilities can be fielded and in what numbers.

Today, the initial parts of the Navy's Family of UUVs complete tasking in support of Environmental Sensing, Mine Warfare, Theater Anti-Submarine Warfare (TASW), and Far Forward missions. UUVs provide access to areas that are prohibitively expensive, time consuming or too hazardous to reach with manned platforms. They provide capacity to conduct cost-effective, important, well-defined repetitive tasks. The Environmental Sensing vehicles provide near real-time, continual updates on world-wide sea conditions in order to provide weather information and optimize sensor performance. The Mine Warfare vehicles conduct hydrographic mapping, reconnaissance, and MCM operations to support Explosive Ordnance Disposal (EOD) and Special Operations Forces. The TASW vehicles support Operational Commanders through the use of modular sensors, payloads, and systems reconfigurable to meet the objectives of Anti-Submarine Warfare missions. Lastly, the Far Forward vehicles are the most advanced UUVs, designed to be launched and operated independently, exploiting the stealth of the undersea while providing the largest payloads and sensor options.

In response, to further address these emerging operational needs, the Unmanned Maritime Systems Program Office (PMS 406) in Program Executive Office Unmanned and Small Combatants (PEO USC) is rapidly developing a robust portfolio of safe, reliable, affordable, and capable UUVs and unmanned surface vehicles (USVs). Resource sponsors include the Director of Undersea Warfare (OPNAV N97), Director of Surface Warfare (OPNAV N96), Director of Expeditionary Warfare (OPNAV N95), and the Office of the Secretary of Defense, Strategic Capabilities Office (OSD SCO).

This portfolio is experiencing significant growth, both in terms of the number of programs under development and in the funding being invested in this rapidly evolving warfare domain. Efficient program execution and the accelerated delivery of these new unmanned capabilities are foundational principles of PMS 406.

The Navy has created detailed visions for UUVs and USVs and their supporting core technology enablers to provide a common framework for aligning the efforts of various program offices, technology developers, industry partners, fleet operators, and Pentagon staffs into a cohesive strategy. The Family of UUVs range in size from small (man portable), to medium, large, and even extra large. The variety of sizes required for both UUVs and USVs is an acknowledgement that one size does not fit all and that a family of systems is needed to accommodate the wide variety of mission requirements and payloads envisioned.

Vehicle size does not necessarily dictate which mission tasking it can conduct as requirements, payloads, and sensors can be tailored as required. In all cases, the desired future state is a common and modular hull form to support serial production and economies of scale using standardized architectures and interfaces that allow rapid integration of new technologies and payloads as they are developed.

UUV sizes are defined by diameter and range, from small (less than 10 inches) to extra large (greater than 84 inches or 7 feet in diameter). Endurance, range, payload capacity, complexity, and cost generally increase with size. For example, a small UUV is generally man-portable with relatively easy mission plans, has endurance of less than a day, a range of aboat 10 miles, small payload capacity, and costs in the tens of thousands of dollars. It can be launched and recovered from just about any host platform including a removable lockout trunk. An extra large UUV, on the other hand, is much more complex, pier-launched, has endurance of months, a range of thousands of miles, a large and flexible payload bay, and costs tens of millions of dollars.

Much of the Navy's current fleet of UUVs is in the medium category (between 10 and 21 inches in diameter). Several program offices, including PMS 406, are developing medium UUVs for mine countermeasures, environmental sensing, and battlespace awareness. The PMS 406 portfolio includes several medium, large, and extra large UUV programs, including some launched from submarines or surface vessels (medium and large) as well as pierside (extra large).

The Navy has identified a complementary set of core technology enablers for both UUVs and USVs whose advancements are critical to the future mission success for unmanned systems. The Navy is following the proven technology-insertion process pioneered by the Submarine Federated Warfare Systems (SWFTS) upgrade program to incrementally deliver capability by advancing technologies in parallel with vehicle development and production schedules. When specific technologies are ready, they will be inserted into UUVs and USVs to increase capability while ensuring production and operations are not adversely impacted.

The modernization process being used by the Navy for these core technologies can then maintain alignment with industry advancements. The Navy has also aligned scientific research and prototyping efforts at the Office of Naval Research, the Defense Advanced Research Projects Agency, OSD SCO, university-affiliated research centers, warfare centers, and industry with PMS 406 acquisition efforts with the overall intent to mature technologies for insertion into operationally ready systems.

The five core technology enablers and areas of research focus are endurance; autonomy and precision navigation; command, control and communications; payloads and sensors; and platform integration. Advancements in each of these areas deliver increased capacity and capability while improving reliability, safety, interoperability, and commonality.

In general, the core technology effort is aimed at harnessing and standardizing ongoing activities across many Navy, Department of Defense (DoD), and industry laboratories and research centers and harvesting the best solutions for integration and deployment on a variety of unmanned platforms.

Complementing and supporting the visions to acquire a capable portfolio of UUVs, USVs, and core technologies are efforts to bring together various Navy centers of excellence and support facilities to prepare for increased experimentation, testing, fleet introduction, and the sustainment of growing numbers of unmanned maritime systems.

The Naval Undersea Warfare Center (NUWC) Division Newport has developed the Navy's UUVs for decades. In addition to directly supporting the Navy's portfolio of UUV programs with personnel, technical expertise, labs, and facilities, NUWC Newport has just awarded an indefinite delivery, indefinite quantity, multi-award contract intended to provide wide access to key industry providers in support of prototyping and fielding a family of UUV systems.

Twenty-three industry vendors were initially awarded contracts to provide services and supplies in functional areas including payloads, hull and structure, propulsion, energy storage/conversion, electrical power, vehicle controller, software, non-payload sensors, vehicle control systems, host platform elements, ashore elements, and internal architecture. This contract is a flexible and powerful tool in support of PMS 406's and other customers' efforts to develop robust unmanned undersea technology.

In addition, the Navy is taking action to ensure that it has capable and proficient operators and the support infrastructure required to effectively manage a growing inventory of unmanned systems. The UUV homeport has been established at the NUWC Division Keyport. The homeport leverages Keyport's facilities and expertise as the Navy's torpedo depot and its close proximity to operational ranges and a fleet concentration area to provide operational readiness for UUV maintenance, integration, and training. Co-located at Keyport is the Navy's first operational UUV squadron, also known as UUVRON 1.

Established in 2017, UUVRON 1 provides dedicated UUV operators and maintainers for the family of UUVs and is closely tied with NUWC Keyport, the acquisition program offices, fleet organizations, and the various resource sponsor offices in the Pentagon to ensure that a coordinated approach exists for the development, fielding, and operations for current and future UUV systems. UUVRON 1 is currently busy experimenting with and operationally deploying a variety of UUVs.

By 2025, UUVs will be conducting more robust and independent missions, including acting as "data fusion" nodes to connect undersea networks and address the need to control the seabed. This remains certain: the demand for UUVs to conduct the "dull, dirty, dangerous, and otherwise impossible" undersea mission tasks will only grow. In anticipation, the Navy developed a clear and comprehensive strategy for the rapid development and fielding of a family of unmanned maritime systems and supporting core technologies to extend the reach, capacity, and lethality of the fleet. PMS 406 will combine acquisition agility with unmanned technology development to deliver "pivot speed at scale," in the lexicon of Assistant Secretary of the Navy for Research, Development and Acquisition James Geurts. It is a high-growth area for both the surface and undersea domains. Key stakeholders are aligned and committed to working together to achieve this vision and to deliver safe, reliable, and capable unmanned systems.

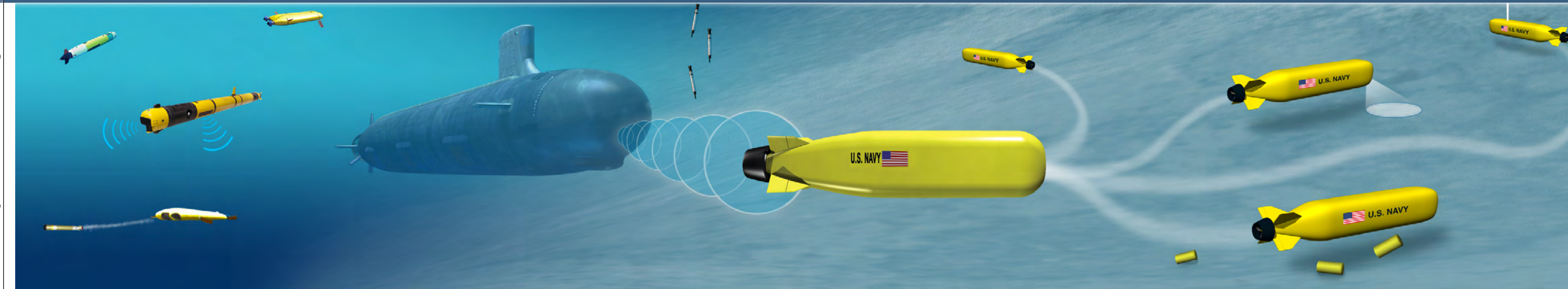
In addition to various prototyping efforts, PMS 406 is executing several high-profile UUV acquisition programs.

Knifefish is a medium-class UUV that operates autonomously from mine countermeasure-configured Littoral Combat Ships or vessels of opportunity and uses low-frequency broadband sonar to search for volume, bottom, and buried mines. The ability to find buried mines is a unique and critical element in the Navy's mine countermeasure kill chain and is a key piece to removing manned ships and crews from the dangers of operating within a minefield. Knifefish successfully completed contractor testing and transitioned to developmental testing in 2018. Milestone C and award of additional low-rate initial production units is anticipated in 2019. A competitive full-rate production award is planned in 2020.

Razorback is also a medium-class UUV that has been modified for submarine use from Naval Meteorology and Oceanography Command (CNMOC)'s highly successful Littoral Battlespace Sensing – Autonomous Undersea Vehicle (LBS-AUV), a program that provides sensing of static and dynamic characteristics and features of the ocean environment in support of military operations. Similarly, the submarine-launched variants—a Dry Deck Shelter (DDS) version and a subsequent torpedo tube launched and recovered version—will extend the reach of a submarine's onboard sensing capability by performing Intelligence Preparation of the Operational Environment (IPOE) independent of the submarine. Razorback's modular, interchangeable sensor packages allow for further mission growth in the future. The first Razorbacks (DDS variant) will be delivered to UUVRON 1 this year with possible support of submarine deployments starting in FY20.

Snakehead is a Large Diameter UUV (LDUUV) for deployment from submarine large ocean interfaces. Phase 1 of the program is a government-led effort and is on track to deliver an operationally relevant prototype to begin testing and submarine integration with the legacy DDS in 2021. Lessons learned from Phase 1 of the program and additional requirements for increased capabilities will be transitioned in 2021 into a competitive procurement of additional industry-developed vehicles. Snakehead is a long-endurance, multi-mission UUV with the capability to deploy reconfigurable payloads. Future missions for Snakehead include surveillance and reconnaissance, mine countermeasures, intelligence preparation of the operating environment, and deployment of various payloads.

Orca Extra Large UUV (XLUUV) program is rapidly progressing into construction of an extra large UUV with a large, flexible payload bay. In September 2017, the Navy awarded contracts to two companies for the Orca XLUUV for Phase 1 design efforts. The speed and innovation associated with these contracts resulted in PMS 406 receiving two DoD-recognized acquisition excellence awards in 2018. Both contractors recently completed critical design reviews and submitted proposals for the competitive award of construction of up to five vehicles to be delivered by 2022. The Navy exercised an option with The Boeing Company to deliver five Orca XLUUVs and associated support elements. The fifth vehicle is not being awarded at this time and is still in source selection. Orca's modular design will enable the UUV to deploy multiple payloads at extended ranges and will be a transformative capability for the Navy, especially the undersea force. Key performance attributes include extended vehicle range and persistence, a reconfigurable payload bay, modular construction, autonomy, and pier-launch capability.



An SSN MODEL for UUV INTELLIGENCE

by Lt. Andrew Tresansky, USN and Dr. David Segala

SSNs are most stealthy and least detectable when operating highly independently and without significant off-hull communication. However, the independence of these operations requires a highly capable and intelligent crew. As UUVs start supplementing the SSN force, increased UUV independence will be pivotal. Improved UUV ability for online decision making in complex environments will drastically reduce the need for communications and therefore increase UUV independence.

We characterize both SSN and UUV intelligence with an OODA (Observe, Orient, Decide, Act)-loop style framework of perception, decision making, and action. Perception is the process in which data are collected and turned into information. Decision making is the use of information to determine the best available action based on a set of constraints. Action is the projection of the decision into the world external to the vehicle. Independence of the vehicle is how much of the perception, decision making, and action loop must be accomplished by an external actor. These functions can be applied to both near-term employment (e.g., UUV path planning or the on-watch members of a SSN crew) and far-term employment (e.g., UUV mission planning or the off-watch operations planning on a SSN). How intelligent an SSN or UUV is determines how independently it can operate.

Perception

Both manned and unmanned platforms cannot rely on a single sensor or sensor array to provide a complete picture of the environment. Various arrays and sensors provide different data (both acoustic and electromagnetic), which are used in concert to provide the most accurate and cohesive understanding of the environment.

On an SSN, perception occurs as the contact management party takes raw sensor data displayed on a console and turns it into usable information for the Officer of the Deck (OOD). On the UUV, perception is achieved through three functions: detection, localization, and classification.[1] Detection is the process of making a decision with regard to an event, in this case when acoustic sound levels exceed a threshold value. Localization is the process of refining bearing and bracketing range, while classification is the process of matching acoustic characteristics of the source to reference source characteristics to determine the source's type. On the UUV, each of these areas use advanced signal processing techniques and algorithms instead of the human-machine mix used on the SSN.

Decision Making

Intelligence is defined as the ability of a system to act appropriately in an uncertain environment where an appropriate action is one that increases the probability of success, and success is the achievement of behavioral subgoals that support the system's ultimate goal.[2] In the perceive-decide-act paradigm, intelligent decision making is the process of taking information and determining the best action given a set of physical and environmental constraints.

The maritime domain presents unique challenges to communications, sensing, and real-time signal processing, which affects decision making. On an SSN, the OOD is making decisions about course, speed, depth, and arrays or masts to use based on knowledge, experience, and a set of established rules and goals. These rules and goals take of the form of mission accomplishment, detection avoidance, and safe navigation. The difference in decision making between a UUV and an SSN is more than just a technical matter. Submarines carry lethal force into forward areas and operate highly independently because the boat's decision making is trusted and predictable. Developing artificial decision making that is similarly trusted will be key to trusting UUVs with higher consequence tasking and greater degrees of interaction with SSNs.

Generally speaking, computer-based decision making can be achieved by rules and heuristics, learning-based techniques, equation-based optimization, probabilistic models, and game theoretic approaches.[3] Each of these approaches is a well-established technical area that considers different inputs/outputs and constraints and offers varying levels of sophistication and complexity.

Rules-based methods, which leverage finite-state machines and heuristics, are widely used in the automobile industry. These methods work well when there are specific conditions and actions that are repeatable and the operating conditions are controlled. In the maritime domain, this is typically not the case, and developing a robust set of rules may be intractable.

Learning-based methods, including artificial neural networks and machine learning, are very data dependent and are used throughout many domains due to their versatility and adaptability. These methods learn relationships, structure, and causal effects from sample training sets and scenarios. Two areas that have shown reliable results in the complex maritime domain are image processing and classification. With improvements in sensor quality, processing ability, and available training sets, current learning-based algorithms are showing tremendous progress in practical applications.

Methods that are more equation-based, such as optimization, probabilistic models, and game theoretic approaches, require models that capture both spatial and temporal characteristics. The models may be challenging to develop or implement if they span multiple temporal and spatial scales. However, when correctly formulated, they create truthful and repeatable results. Platform route planners and task allocation are two areas that successfully use these methods and are showing promising results in in-water demonstrations.

Independence

Independence is the degree of external involvement in the local perceive-decide-act loop. Lower independence requires communications that are more frequent, lower latency, and higher in information content while higher independence is characterized by the opposite. Fundamentally, because less involvement is needed in a more intelligent vehicle's perceive-decide-act loop, it is capable of greater independence.

For example, an SSN in Emissions Control is wholly independent and limited in communication but has weapons release authority under rules of engagement. Conversely, a remotely operated vehicle (ROV) operating on a tether has near-zero independence. In between are human-in-the-loop and human-on-the-loop control. Human-in-the-loop control is when higher authority has functional responsibilities inside the perceive-decide-act loop. Human-on-the-loop allows the perceive-decide-act loop to operate quasi-independently, but certain high consequence actions require approval.

Similar to an SSN, UUV communications present potential for detection and consequently should be minimized. Alternatively, low levels of UUV intelligence will drive low independence and require communications, reducing the UUVs effectiveness. Forthcoming advances in UUV intelligence and ability to handle more complex decisions and environments will allow more independent operations and consequently the transfer of less difficult tasking from SSNs to UUVs.

There has been significant work for several decades in developing the technical areas of computer-based perception and decision making as well as efforts to improve the actions UUVs are physically capable of. Current UUVs range from tethered ROVs to complex UUVs capable of moderate levels of independence under benign conditions. As the latter become more widespread and their intelligence more robust, more difficult and independence-enabled tasks will be achievable with UUVs.

Over the past 20 years, there has been significant work in the technical areas of perception, decision making, and action that have increased UUV intelligence to a level where UUVs will soon operate with SSN-like independence. This promises to be a force multiplier in the realm of undersea warfare by outsourcing mundane tasking from SSNs to UUVs. As UUVs proliferate and grow smarter, thinking of their intelligence in terms of our own may make them seem less arcane. Understanding UUVs will allow us to design them more effectively, employ them more proficiently, and ultimately maximize our undersea advantage.

References

1 Hodges, Richard P. Underwater acoustics: Analysis, design and performance of sonar. John Wiley & Sons, 2011.

2 Albus, James S. "Outline for a theory of intelligence." IEEE Transactions on Systems, Man, and Cybernetics 21.3 (1991): 473-509.

3 LaValle, Steven M. Planning algorithms. Cambridge university press, 2006.

CORE TECHNOLOGY INVESTMENT AREAS:

Empowering the Unmanned Maritime Revolution

by Capt. Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406)

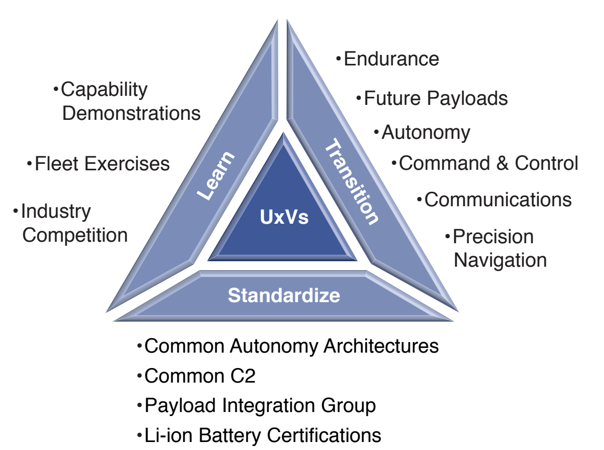
Several new classes of unmanned vehicles will arrive at the unmanned undersea vehicle (UUV) homeport in Keyport, Wash., in late fiscal year (FY) 2020. With construction of the Orca-class Extra Large UUV (XLUUV) just commencing, a significant new capability is on the cusp of being delivered. At over 85 feet in length and 140,000 pounds, the XLUUV is intended to be pier-launched forward and complete its mission autonomously with little to no external communications or human interactions. Similarly, the Snakehead Large Diameter UUV (LDUUV) will complete design this year, allowing for autonomous operations from a host submarine's dry-deck shelter.

Requirements for the next-generation medium-sized vehicle (Razorback) are currently being drafted, however this vehicle is intended to reduce diver operations by being launched and recovered via torpedo tube. As both Snakehead and Razorback are launched from submarine platforms, these vehicles are intended to reduce the burden on manned platforms by performing many of the lower-end, time-consuming tasks best suited for the unmanned platforms.

As innovative and impressive as these unmanned vehicles (UxVs) are, each is enabled by the advancements in emerging "core" technology areas such as autonomy, communications, and precision navigation. Equally important to future missions are integration of new payloads and increasing the endurance of the vehicles.

Recognizing the need to invest in these technology areas, the Navy started the "Core Technology Portfolio" in FY 2018 managed by the Unmanned Maritime Systems Program Office (PMS 406). This portfolio has three purposes: transition maturing technologies into the entire UUV family of systems; enable learning through fleet experimentation and industry engagement or demonstration; and drive standardization across UxVs.

Standardization efforts such as common autonomy architectures, common command and control, and common payload interfaces were the initial efforts to drive down costs, encourage commonality, and ensure re-use.



Common Autonomy Architectures: A barrier to rapidly fielding improvements has been that each UxV platform uses different autonomy architectures. Advancements made using one architecture required changes in order to be compatible with another, often proprietary design. Starting in 2018, a team of experts was tasked with developing the Unmanned Maritime Autonomy Architecture (UMAA). This standard focused on opening up autonomy interfaces for all UxVs, making them non-proprietary. The UMAA is still in its infancy. However, as these standards mature and more platforms use them, they will allow the Navy to rapidly advance autonomy across all platforms that share this architecture. This first UUV contract to use these architectures will be the Razorback, followed by LDUUV platforms.

Common Control System (CCS): Today's unmanned platforms are controlled from many different consoles, increasing the number of operators, amount of training time, and physical space in operations centers. Starting next year, the Navy will require new programs to use the CCS software capable of controlling air, ground, and maritime unmanned vehicles from a single, common controller. This change will enable commonality on submarines, ships, and operations centers. As CCS is an air-centric software suite managed by Naval Air Systems Command, FY 2019 the Navy will focus on getting the maritime requirements, funding and a roadmap in place to enable seamless transition for future maritime programs.

Payload Integration Group (PIG): Chartered with standardizing payload interfaces for each vehicle class, the long-term vision is to make payloads "plug and play" based on the mission being performed without the need to return to a vendor for support. To accomplish this, the group is tasked with standardizing the payload interfaces for the medium UUV that will go out to industry next year.

Energy and Endurance: The Navy is working multiple efforts to develop and implement more energy-dense power solutions to increase the capability of the entire unmanned systems portfolio. Near-term efforts are focused on establishing efficient and technically acceptable requirements for testing rechargeable lithium-ion (Li-ion) battery systems; establishing updated, informed submarine "hostability" requirements; and developing propagation-resistant battery architectures to enable safe integration and deployment from Navy platforms.

The Navy has committed to Li-ion battery technology for UUV programs intended for submarine integration in the next several years for both its high energy density and recharge capabilities. Li-ion batteries are unique in that they contain enough stored energy to meet requirements but can pose a significant fire hazard upon failure. This poses a risk to both the submarine platform and its crew.

Good design principles and engineering solutions can eliminate fire hazards such as those that have been experienced in hover boards and Samsung phones. Previous Navy efforts focused on leveraging the low probability of failure for the certification of Li-ion-based systems. As rare as these failures are, the potential risk for larger systems (i.e., Snakehead, Razorback, etc.) embarked on a submarine is unacceptable.

In an effort to meet fleet requirements for increased endurance, a team of engineers and fleet operators have come together to achieve the certification of Li-ion-based systems using a systems-based approach. The team developed the submarine Li-ion embarkation strategy of prevention/detection/mitigation.

The prevention leg is grounded in the use of highly engineered battery systems with the goal being battery systems that are resistant to propagation upon failure. A robust quality-control process will help ensure that battery cells are screened to minimize the probability of failure. Additionally, the Navy has partnered with NASA to leverage the propagation-resistant battery architecture developed for manned space operations along with its battery design principles. An initial demonstration effort has begun with the integration of the NASA spacesuit battery in a small-size prototype UUV, which is being developed for submarine deployment.

The detection leg will alert the submarine crew of a failure early enough for it to take action, ensuring both survivability and resiliency. The Navy has partnered with Sandia National Laboratories and industry to develop a battery casualty detection system that is both coincident and redundant. Future efforts will incorporate emerging technology that will periodically scan the batteries for signs of internal faults allowing the submarine crew to simply discharge the battery, rendering it safe before a catastrophic failure occurs.

The third leg relies on a qualified, certified, crew-based mitigation concept of operations using organic shipboard capabilities (i.e., firefighting, smoke management, etc.). Crew training/certification and approved procedures will result in a standard for fighting a battery fire that is similar to Submarine Force Operational Training and Procedures. This was demonstrated aboard USS *Boise* (SSN 764) during a fleet engagement in which the crew helped the team refine and simplify the proposed torpedo room firefighting procedure for a Li-ion-powered Razorback UUV.

The submarine Li-ion embarkation strategy of prevention/detection/mitigation is changing the way engineers and fleet operators approach endurance, allowing the Navy to confidently develop Li-ion-based systems capable of being certified for submarine deployment.

As with the other core technology efforts, it is aimed at harnessing and standardizing ongoing activities across many Navy, Department of Defense, and industry laboratories and research centers and harvesting the best solutions for integration and deployment on a variety of unmanned platforms.

Collectively, investing in core technologies and rapidly maturing their evolution is critical to enabling the mission sets envisioned for UUVs. Some current technology paths may prove unsuccessful while new directions will emerge from continued research and testing. We should be prepared for these ups and downs, harvest the lessons learned, and move out smartly in a different direction.

As Navy Secretary Richard Spencer said in a recent speech, "An environment for exploration and experimentation must be tolerated. … We have to rub the rails." The core technology effort for unmanned maritime systems is pushing ahead with all deliberate speed.

Dr. Joseph Fontaine, Head, Propulsion and Energy, Naval Undersea Warfare Center, Newport Division, contributed to this article.

by Lt. Cmdr. Stephan Boatwright

UUVRON 1: The Future of Naval Unmanned Undersea Operations

The Navy has a long history of employing Unmanned Undersea Vehicles (UUV) for oceanographic surveys, research and development (R&D), and various sensor employment, all meant to enhance the warfighters' ability to extend the reach of sensor capability. The Navy recognized the advantages of UUVs in reducing the risk of dangerous manned systems operations. This utility coupled with the need to develop operational Tactics, Techniques and Procedures (TTP) that harness the innovation found in both government and industry technologies revealed the need for a specific organization to manage and opererate UUVs.

The Chief of Naval Operations established Unmanned Undersea Vehicle Squadron ONE (UUVRON 1) as the Navy's first dedicated UUV command on October 1, 2017. Cmdr. Scott J. Smith was selected to be the first Commanding Officer of UUVRON 1 almost a year prior to the official stand-up of the new command. This allowed Cmdr. Smith to better manage the transition from the previous Submarine Development Squadron FIVE (CSDS 5) UUV Detachment. UUVRON 1 is an Echelon 5 Command, which reports directly to CSDS 5, currently led by Commodore Steve Mack. UUVRON 1 also contributes to the nation's Disabled Submarine Search function under an agreement to support Undersea Rescue Command.

"Cmdr. Smith started with only 22 personnel with a handful of vehicles across a set of defined mission sets to operating several dozen vehicles supporting multiple task force commanders across the globe. UUVRON 1 has doubled in size and is slated to be over 55 Sailors by the end of this year," said UUVRON 1's Executive Officer, Lt. Cmdr. Steve Boatwright. "UUVRON 1 is a new command and is setting the stage to seed the Fleet with UUV experts. Right now, only second sea term or higher Submariners, who must also meet the additional requirements for working in Submarine Special Projects, can currently apply to work at UUVRON 1. As the mission requirements, training, and technology of UUVs continue to grow in the next couple of years, UUVRON 1 will eventually support billets of many other ratings not limited to the Submarine Force, such as Operations Specialists and Aerographer's Mates, but applicants will still be required to meet the Submarine Special Projects criteria."

UUVRON 1 is UUV system agnostic. The command works closely with specialized UUV operators from around the Navy and partners with industry and academia across the Department of Defense to develop the expertise in house to carry out its tasking. These interactions and engagements with all things UUV allow for the crew of UUVRON 1 to become integrated into cutting-edge UUV technology and glean lessons learned from current UUV operators to develop flexible and proficient UUV specialists.

UUVRON 1 is capable of operating all classes of vehicles from small vehicles such as the commercially available

Photo by Mass Communication Specialist 1st Class Amanda R. Gray

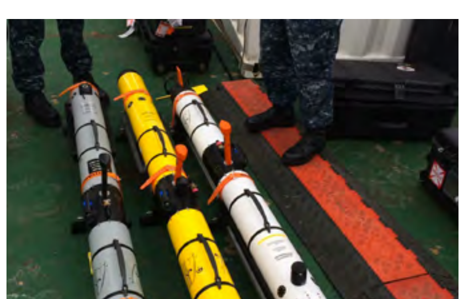
Cmdr. Scott Smith, delivers remarks during the establishment ceremony for Unmanned Undersea Vehicle Squadron (UUVRON) 1. UUVRON 1 was originally a detachment that fell under commander, Submarine Development Squadron 5.

L3-OceanServer IVER-580, medium vehicles such as Bluefin Robotics, BF-12D, to the large and extra-large systems currently under development by Navy program offices. Sailors are tasked with learning to operate and repair most UUV systems and are able to do this currently by attending factory maintenance schools. They conduct frequent UUV familiarization through on-the-job training and industry demonstrations. UUVRON 1 develops and implements the TTP as well as designing all UUV training and qualification programs necessary to complete tasking. Currently, TTP development is primarily for commercial-off-the-shelf vehicles until programs of record are developed.

Small UUVs

The cadre of small UUVs conducts mission planning and post-mission analysis with IVER 580-sized UUVs. The IVER is 80 inches in length, 5.8 inches in diameter, and weighs around 85 pounds. Since the IVER is commercially available, many other organizations both civilian and military employ it. The small-UUV staff developed the TTP for disassembling the Lithium-ion-powered IVER to allow for safe travel on any commercial or military flight. This capability ensures the agility and rapid deployment ability of the small UUVs anywhere in the world. This was recently tested and proved successful using commercial air when called on to support the search for ARA *San Juan*.

In addition to standard tasking for oceanographic surveys or bathymetry, small UUVs are capable of complementing diver teams in a variety of mission types. The small-UUV team, working with a group of divers, traveled to Point Loma in San Diego, Calif. to conduct a multiple parallel leg or "lawnmower" search pattern of the bottom area around the Point Loma pier to determine if the bottom was safe



for deep draft vessels to moor after a recent dredging. In the past, divers conducted this type of search manually, which required spending over a week with a hand-held sonar carefully surveying the bottom. The small-UUV team, using an IVER vehicle, accomplished the same search result in eight hours. Subsequently, the small-UUV team found several items that posed a potential risk to a deep draft vessel and labeled each according to depth and size severity. This UUV mapping allowed the divers to rapidly assess the critical items, dive directly over the mapped objects, and remove them. It is not hard to imagine how the skills learned during this task would easily translate to clearing a far forward port following a hurricane or attack.

Medium UUVs

The medium-UUV cadre employs REMUS 600 UUV systems in a variety of configurations. Vehicles from 140 inches long up to 163 inches, 12.75 inches in diameter, and 600 pounds to upward of 800 pounds. Many different types of sensors and payloads are possible, but most are designed and used to survey the ocean bottom. Several other payloads are in development to support future mission plans and capabilities. The vehicle is capable of conducting operations for about 24 hours using an alkaline battery as its energy source. Subsequent missions require a full change out of battery packs. This system can be launched and recovered from many platforms, including a Submarine Dry Deck Shelter.

The medium-UUV group is heavily involved in R&D of the Navy's first Submarine Force UUV Program of Record, RAZORBACK. The team participates in not only the design of RAZORBACK, but also provides technical inputs for the planned RAZORBACK Interactive Electronic Technical Manual (IETM). The medium-UUV force attends all factory and Fleet training for both operations and maintenance of RAZORBACK and maintains proficiency operating medium-sized UUVs for several Applied Research Laboratories (ARL) and other programs. They have supported multiple operations around the world for more than five years including source of supporting multiple medium UUV missions launched from submarines.

Large UUVs

The large-UUV (LUUV) cadre is currently focused on the movement and technological capabilities that a large-diameter vehicle offers. As UUVRON 1 prepares for the delivery of its first LUUV program of record vehicle in the next few years, the team attends focus groups that include discussions on maintenance, payload integration launch and recovery concerns, and other requirements that affect a vehicle of this size.

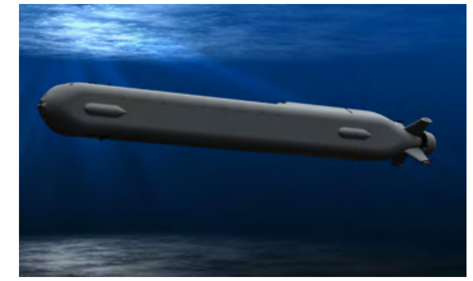
The team also works with NUWC-Keyport to learn how to maneuver such a large vehicle inside and from a shore facility to a sea-going state or platform and how to prepare for a deployment. This includes developing the support infrastructure concepts and emergency handling methods of a vehicle that is estimated to be 54 inches in diameter. Most of these development efforts for handling LUUVs use the Office of Naval Research Innovative Prototype #2 (INP2).

Some of the planned technological upgrades include fuel-cell power source prototyping and improved methods of navigation and sensor package employment, efforts that are assisted by ARL Penn State's local Keyport team and use of their Large Test Vehicle 48 (LTV-48).

eXtra Large UUVs

The extra-large-UUV (XLUUV) cadre is integral to the design, functionality, logistics, and future delivery of the XLUUV system, also referred to as ORCA. In addition to providing direct feedback to the manufacturer and program office for use of this size of vehicle, UUVRON 1 attends all briefings and homeporting plans to help ensure that future requirements for an XLUUV are achievable.

As a first-of-its-kind effort, XLUUVs will possess some of the most advanced undersea



technology available including propulsion, communications, autonomy, sensors, and payloads. UUVRON 1 is the direct link for the program office for prototyping and officially developing XLUUV deployment around the world. UUVRON 1 is expecting the receipt of the XLUUV program of record, ORCA, to arrive in 2021. The specific missions of this vehicle are currently under evaluation, but are anticipated to support numerous global operations.

In addition to supporting tactical operations, UUVRON 1 provides services to strategic oceanographic monitoring and Theater Anti-Submarine Warfare prototype systems. UUVRON 1 operators are capable of globally monitoring underwater vehicles around the clock for several days unassisted and, with reservist support, up to several months. UUVRON 1 often supports long periods of vehicle testing and training across the country. This maximizes the experience the UUVRON 1 operators gain with each system while developing close relationships with technical teams and engineers. This improves their system knowledge and leads to more extensive Sailor-conducted troubleshooting and repairs in the field.

UUVRON 1 is no stranger to hard work. Since standing up as a command only 16 months ago, UUVRON 1 Sailors have deployed on three submarines, operated from several surface ships, locally conducted hundreds of hours of at-sea testing, are involved in almost every UUV working group, and provide daily UUV support to Task Force commands. However, despite the busy schedule of the small command, the job is very satisfying. To quote Cmdr. Smith, "I am constantly amazed at how my team gets it done with professional execution every time. They are doing first-ever evolutions and go after every challenge with a smile on their faces. This is the best job in the Navy, and I will surely miss it." Cmdr. Smith was relieved by Cmdr. Robert Patchin on March 22, 2019. UUVRON 1 will continue to operate UUVs in new ways, further develop UUV capabilities and extend the reach of existing submersible systems around the globe.

Search for the San Juan

The ARA *San Juan* (S 42) was a diesel-electric submarine in the Argentine Navy. *San Juan* was commissioned in 1985 and participated in a fleet exercise with the U.S. Navy in 1994. When the *San Juan* was declared missing in November 2017, UUVRON 1 supported the American contribution to efforts to locate the missing allied submarine, last reported over 200 miles off the coast of Argentina. The team arrived in Buenos Aires embedded with Undersea Rescue Command (URC) within 48 hours of notification and began searching for the *San Juan* 24 hours later.

Drawing upon their expertise with acoustic imagery, UUVRON 1 Sailors ran analyses on several days' worth of data collected by URC equipment and directly surveyed one potential site conducive to UUV operations. The location was identified separately via magnetic anomaly detection as harboring a large, metallic object. The object turned out to be a fishing wreck, but the site was removed from consideration as a result. The team was able to rule out a number of other possibilities over an area spanning 7,000 square miles.

Due to the independence of the UUVs and fidelity of the sensor systems, UUVRON 1 Sailors were able to investigate with greater resolution than most surface-deployed survey methods. Unfortunately, the *San Juan* was not located during the URC operations period, but the experience gained by UUVRON 1 Sailors using UUVs in actual operations was invaluable to the evolution of UUVRON 1 mission planning and target localization capabilities. As Submariners, the Sailors of UUVRON 1 considered it an honor to assist in any way possible when the call came to look for missing shipmates, whether or not they flew a different flag.

Photo at left: The entire URC-UUVRON search team aboard the Skandi Patagonia.

by Capt. Anthony Carullo

A Fighting Ship of the Highest Order

PART III: Building a Culture of Combat

From the Editor: This series continues to highlight the importance of a warfighting culture and mindset aboard our submarines. On shore, our commands will conduct warfare with charts, maps, and operational plans, but at sea our submarine COs and their crews will be required to engage in the actual combat—a more dangerous, personal, and visceral endeavor in the profession of arms. Capt. Carullo continues the theme of developing a crew that is ready to fight. You can read part I, "A Fighting Ship of the Highest Order—Procedural Compliance: The Bedrock for Bold and Deliberate Action," and part II, "A Fighting Ship of the Highest Order—Dicta of Submarine Attack," in the Winter 2013 and the Winter 2016 editions of *UNDERSEA WARFARE Magazine*.

The U.S. Submarine Force is a profession of arms, a lethal and asymmetric force that must stand ready to answer the nation's call to deliver swift and destructive violence from the depths. Though the bulk of a Submariner's career is spent deterring conflicts by accomplishing the myriad of peacetime missions, our force, our commanding officers, and their crews must be ready to fight. All the decades of training, preparing, and deploying will be recorded in the annals of history as a complete waste if we are not ready for combat. Combat readiness must transcend everything we do.

Success in battle rests solely on the CO's ability to establish a combat culture on board his ship well before it will ever be tested in battle. No amount of just-in-time training, motivational speeches, or patriotic call-to-arms will prepare his crew for battle unless he has instilled a battle-ready culture well before the first torpedo homes for attack. His ship, torpedoes, and supporting weapon systems are only a means to an end. It is only with a trusted CO, a disciplined crew, and the confidence that both will be tough in battle, can our Force take on a capable adversary, be victorious, and stand proud as we are judged in the history books.

To build a combat culture necessary for a fighting ship of the highest order, the CO must establish, develop, and maintain these three decisive cultural and critical elements on board his ship. Without all three the CO risks failure when attempting to unleash his submarine and untested crew on an enemy that may have already developed these elements on *his* ship. The CO may face an apparently less capable adversary, but if the adversary has honed the skills of *his* crew and has gained the trust of *his* men, the CO may be up against a more confident and lethal opponent that has overcome the weakness of *his* ship and weapon systems to be victorious in the engagement. No amount of boldness can overcome the shortfalls of these three critical elements.

Trust and Vision

Too often leaders unduly emphasize the need to trust their subordinates over the trust his Sailors must have in him. Although the importance of trusting his Sailors is crucial—which is what the awarding of Submarine Dolphins represents—COs sometimes take for granted that their subordinates trust them. Since the CO is the only decision maker with the skills and experience necessary to press an attack well past what the crew would safely endure on their own, the trust the crew has in their CO—the only thing they may have to cling to when enduring banging decks, smoking equipment, and the visible wounds of their fellow shipmates—is of greater importance.

The CO must develop, hone, and demonstrate his own combat skills so that his crew has the confidence that he will deliver them safely through the battle. The crew must have confidence in battle that the CO will keep them from the brink of defeat. His demonstrated confidence is their confidence, his combat skills are theirs. If they have this confidence, his Sailors will rally around his leadership and trust his orders. So when the CO asks for the last drop of blood and sweat, they will be ready and capable to deliver. They trust he will only ask for their sacrifice when he truly needs it.

The trust the CO seeks is not through bravado, bluster, or swagger. Instead it is built on a solid foundation of confidence, humility, and unswerving dedication to ready his ship and crew for the attack. The trust our Sailors have in their CO allows the CO's vision of perfection, strict demand of discipline, and call for toughness in the face of the enemy to be realized. The CO knows that this culture has been established aboard the boat when his crew sees all of their peacetime endeavors through the lens of combat.

Disciple in Battle

As any world class athlete knows, individual skills must be developed and strengthened, and weaknesses wrung out. It doesn't matter if he or she stands alone on the field of battle or is part of a larger team, individual skills are necessary to effectively integrate into a highly functioning larger organism. Discipline is the manner in which both the individual and the team achieve greatness. The CO must tenaciously develop his Sailors to fully support his combat team.

Discipline comes through thousands of hours of perfect practice—training, planning, repetition, correction until the desired skills are perfected, being both right and fast, to achieve the CO's expectations necessary for the fast-paced, stressed-filled conditions of battle.

As our battle-hardened COs of WWII learned, today's COs must constantly and aggressively gun-drill their routines until his expectations are met to perfection. It is more than becoming proficient, it is the strive for perfection that may be necessary to deliver the ship and the crew out the other side of battle. Good enough may not be good enough in combat.

Toughness

The third crucial element in developing a combat culture aboard a fighting ship of the highest order is developing Sailors who are tough. Toughness starts with readiness—mental, physical, and virtuous toughness. Our Sailors must be mentally tough to be able to handle the stresses that come in battle—fear, fatigue, and the demoralizing failure that comes when their shipmates are hurt, their equipment malfunctioning, and the exhausting push by their CO to perform in the face of a fierce enemy.

The crew's mental toughness is forged with strong individual character. Virtue, integrity, and a devotion to a higher cause is the only firm foundation to build tough Sailors on. The misbelief that bravado and mistreatment will build tough Sailors will only lead to a hollow crew unwilling and unable to stand tall in the hell-fires of combat. Character and toughness are complementary, not in conflict with each other, and the CO must take ownership of both.

The CO's Ultimate Responsibility

These critical elements of a fighting ship of the highest order must be singularly owned by the CO, and his responsibility to prepare his ship for combat cannot be delegated. His officers and chief petty officers must prudently support his responsibility to develop his Sailors. Any dissent, any misalignment, will be fatal.

In the heat of battle only the CO will know when to fight it out, when to fight through, and when, if necessary, to not fight at all. No school, no examination, and no peacetime stress will come close to simulating combat conditions. Combat will require tenacity, boldness, and quick decision making to overcome its inherent fatigue and stresses of combat. The best protection against the recklessness of entering into combat without a tested crew is to have a trusted CO, a well- disciplined ship, and a tough crew.

Not only will these critical elements pay off in battle, but they will pay dividends during all our peacetime operations. With a combat culture, our Submarine Force will be victorious and uphold the same fighting spirit of those that were tested in the crucible of WWII.

Captain Anthony Carullo is currently the Chief of Staff and Deputy Commander, Submarine Force, U.S. Pacific Fleet in Pearl Harbor, Hawaii. He previously commanded USS *Greeneville* (SSN 772) in Pearl Harbor, Hawaii and TASK FORCE 69 in Naples, Italy.

Connecting Technologies to Fleet Operators

by NUWC Newport Division Public Affairs

Consistent with the theme of Human Machine Interaction (HMI), the 2018 Advanced Naval Technology Exercise (ANTX) at NUWC Newport Division explored ways in which science and technologies that enable or achieve coordinated detection, localization, tracking, and/or targeting for undersea, surface, and air environments enable human trust in machines to support operational decision-making.

NUWC Newport Division hosted ANTX HMI 18 August 29-31 at its Narragansett Bay Test Facility with the main goals of collaboration, innovation, and obtaining fleet feedback.

It was the largest ANTX hosted at NUWC Newport Division in terms of the number of participants, vehicles, and technologies since the event began in 2015. The exercise involved more than 55 participants from industry, academia, and government as well as fleet personnel who provided critical feedback to participants.

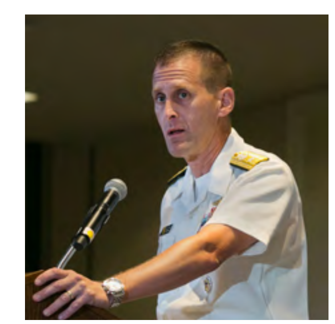
Collaboration

NUWC Newport Division partnered with Commander, Naval Meteorology and Oceanography Command (CNMOC), located in Stennis, Miss. CNMOC conducted operational exercises as part of ANTX throughout the summer. Operational teams worked with partners to complete numerous vignettes, including human-machine optimization for seafloor mapping with industry partners, wide area search with the Naval Oceanographic Office, intelligence preparation of the operational environment (IPOE) for naval special warfare with the Naval Oceanography Special Warfare Center (NOSWC), and IPOE for mine warfare with the Naval Oceanography Mine Warfare Center.

The NUWC-CNMOC partnership underscores a commitment to understanding and developing the undersea battlespace for both manned and autonomous vehicles. CNMOC has two decades of experience operating more than 20 different unmanned systems that are highly dependent on meteorological and oceanographic conditions for mission success.

"We have to thrive," said Rear Adm. John Okon, Commander, Naval Meteorology and Oceanography Command. "Most critical to the Navy and the nation is innovation. The speed to innovate is critical. Long-term strategic competition among nations is most evident at sea. Naval oceanography has to be an early adopter of new technology.

"The demonstrations performed at CNMOC's ANTX gave Navy leadership a first-hand assessment of what we can accomplish—IPOE and hydrographic surveys in large quantity," he said. "Our demos gave a glimpse into the future of naval oceanography. Autonomy is critical. How to build on successes? Be quicker and tap into small business innovations. We need these partnerships to grow. This will get the latest technology to the fleet. We need to spread the word of the success of ANTX."



"Most critical to the Navy and the nation is innovation. The speed to innovate is critical. Long-term strategic competition among nations is most evident at sea."

—Rear Adm. John Okon, Command, Naval Meteorology and Oceanography Command

During the ANTX opening ceremony, Capt. David Bauer, Director of Rapid Prototyping, Experimentation and Accelerated Acquisition for the Deputy Assistant Secretary of the Navy (DASN) for Research, Development, Test and Evaluation (RDT&E) said that new technical focus is required to maintain strategic advantage and pointed to areas such as hypersonics, directed energy, machine learning, quantum science, and microelectronics that are of particular interest to DASN.

"ANTX is meant for exploration and experimentation," Bauer said.

Many of the projects presented this year were the result of collaboration at previous ANTX events, creating synergies and building upon one another.

Rob O'Malley, Sales and Business Development Manager at iXBlue, brought the Global Acoustic Positioning System (GAPS) to operate with the fleet at CNMOC. "We really had a great experience," O'Malley said. "We achieved dozens of objectives, in fact, meeting a number of different interests that this enabling technology could fit for the Navy. Last year the tech warrants, who really understand how the technology works, helped us understand where the value was for the Navy. That's how we got connected to CNMOC so we could go to work with operators and understand the value of what it could bring. It's been a great learning experience for us."

Jeremy Barstrom, Emily Cushing, and Jennifer Sakowski from General Dynamics Electric Boat stand in front of the Build Authority Technology Mobile, or BAT mobile, a mobile classroom to teach tradesmen how to build ships.

Innovation

Technologies at ANTX HMI 18 ran the gamut from first-of-its-kind technologies to commercial-off-the-shelf products, while participants included both large and small companies, government, and academia. The following is a small sample of innovative solutions presented at the event:

- NUWC Newport Division's Energy and Propulsion Branch exercised its non-mechanical transducer, which uses carbon nanotube fibers. The team of NUWC scientists and engineers partnered with QinetiQ North America to integrate their innovative sensor technology with QinetiQ's SeaScout UUV. The pings from the thermophone inside the UUV were "loud and clear."
- Z-senz LLC, a small company from Maryland founded in 2015, developed an underwater light detection and ranging (U-LIDAR) sensor. They integrated their technology in NOSWC's IVER3 UUV. The Z-senz team was able to implement feedback as a result of the collaboration with NOSWC and has since made the technology more useful for fleet applications.
- Huntington Ingalls Industries partnered with Advanced Acoustic Concepts and Battelle to demonstrate a single-sortie, detect-to-engage capability using the Proteus Large UUV and the Angler A-sized UUV. The sortie was conducted at Panama City, Fla., and video of the exercise was displayed at ANTX, as was the Proteus vehicle.
- Teledyne Brown Engineering and Teledyne Energy Systems joined forces for an exercise titled "Fleet-wide damage control and ship's husbandry ROV." An autonomous undersea fuel cell (Teledyne Energy) powered the SeaBotix remotely operated vehicle (ROV) to demonstrate ship's husbandry including hull and running gear inspections.

"The participants at ANTX HMI 18 proved what it means to innovate," said Nick DelGreco, ANTX Integration Lead. "Some participants tested prototypes at ANTX that were merely ideas nine months ago. Others integrated their hardware or software with UUVs or UAVs to conduct previously untried exercises. Participants were not afraid to fail, something that is critical to innovation."

Rhode Island Senator Sheldon Whitehouse being briefed on the Huntington Ingalls Proteus technology.

Ryan Parker (far right) from Advanced Acoustic Concepts briefs a scalable, deployable command, control, and communications system for unmanned vehicles at ANTX 2018.

Feedback

A comprehensive feedback effort was new to NUWC Newport Division's ANTX this year. Craig Sawyer, who is in NAVSEA Commander's Executive Fellows Program, and Lauren Konrath, data analyst at NUWC Newport Division, led the fleet feedback effort, preparing feedback surveys and the method for data collection.

"We have taken leadership and operators from the field and given them a chance to have direct input to emerging technology prior to first government contact with the acquisitions process," Sawyer said. "With the feedback collected, we are influencing industry and academia through education of military needs and desires."

Feedback was provided from both a fleet/operational perspective as well as a technical perspective. For an operational perspective, a team of 18 represented Unmanned Underwater Vehicle Squadron, Office of Naval Research (ONR)/Naval Research Laboratory (NRL), Marine Corps Warfighting Lab, NUWC military detachment, Special Operations Command, OPNAV N81, and CNMOC. For a technical perspective, a team of 17 represented ONR/NRL, OPNAV N8, CNMOC, and all of the NUWC Newport Division technical codes.

In total, 511 surveys of the ANTX technologies were completed—260 operational and 251 technical. Technology-specific comments regarding sensors exercised at ANTX will help participants shape their technologies as they evolve.

"ANTX provides the ability for the warfighter to speak directly to designers and explain what survives and adds value to military operations," Sawyer said. "We work in a unique environment; there are few communities outside the warfighter and Navy engineering community that have the experience and perspective we shared during ANTX. It was a unique opportunity where all stakeholders, from developer to fleet operative, get a chance to mold the clay of future concepts. The exercise allows engineering, acquisitions, operations and designers to exchange ideas at such a fluid time of development; no requirements are in the way of the free exchange of ideas and suggestions at ANTX."

ANTX participants also were asked to provide feedback on their experiences. Responses such as "The number of government representatives on hand to discuss requirements and help share internal R&D (research and development) was invaluable," "Our exercise was successful and will guide our plans going forward," and "We were able to succeed with the Navy's help," will shape the series as it moves forward.

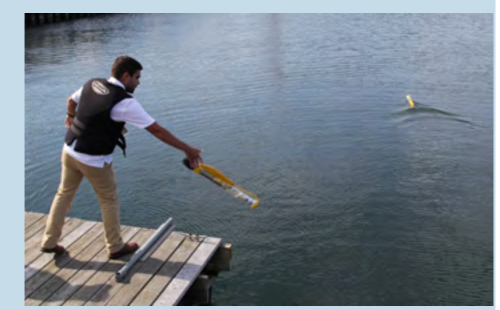
Naval Oceanography personnel and industry partners monitor autonomous survey platforms from a Forward Operating Base at The University of Southern Mississippi's Marine Research Center in Gulfport, Miss., during the Gulf Coast portion of Naval Undersea Warfare Center's ANTX 2018.

Attendees' feedback on their experiences indicated that the event achieved its goals. When asked what they liked about the event, attendees pointed to the technologies: "Saw some fantastic tech; very open discussion," "Exposure to cutting edge technologies, along with opportunity to discuss systems and concepts in depth with system developers," "Technologies covered full spectrum from near pure science to ready-to-deploy-systems or uses of existing TRL (technology readiness level) 9 systems," and "Seeing the small companies and new ideas, seeing how cheap tech is being leveraged and defense solutions."

Since its inception in 2015, ANTX has been NUWC Newport Division's annual culminating event created specifically for the Navy to see the future of technology in action today.

"We have stayed true to its founding vision of providing a lower-risk environment where scientists and engineers can evaluate their technological innovations at the research and development level before their technology has to become militarized and interface at the operational level of the Navy," said Dr. Peter Hardro, ANTX Director. "However, we have also evolved ANTX over the years by experimenting with the theme, our partners, and our processes. For example, this year we focused on strengthening our approach for providing written feedback to our participants. ANTX remains a catalyst for collaboration, innovation, and fleet feedback, and we look forward to evolving ANTX further in 2019 during our 150th year anniversary."

AquaBotix SwarmDiver™



Also demonstrated at the most recent ANTX was the SwarmDiver™ by AquaBotix, which is a micro UUV drone capable of operating as a group—or swarm—with other SwarmDiver™ drones. At just less than 2.5 feet in length, just wider than 5 inches in diameter, and weighing a little more than 3.7 lbs., SwarmDiver™ is easily deployable and recoverable on the surface, whether manually or autonomously. It can travel at a speed of up to 4.3 knots for 2.5 hours for a distance of more than four miles.

Aside from its obvious uses in oceanography, aquaculture, research, and hydrographic surveying, the U.S. Navy has asked Aquabotix to work with the Naval Undersea Warfare Center Division Newport for testing SwarmDiver™ for use in defense applications. These would include missions such as intelligence and data collection, environmental monitoring, mine detection, decoy, stealthy data transfer, and target neutralization. SwarmDiver™ can also be customized to carry different sensors and payloads.

Because SwarmDiver™ UUVs can communicate with each other, they can "think" and operate as a single entity and be operated by a single individual. The operator sends commands to the swarm rather than to each individual UUV. This enables SwarmDiver™ UUVs to quickly arrange themselves into various swarm formations to suit the task at hand.

SwarmDiver™ can dive to a depth of 164 feet (50m), wirelessly transmit data back to the operator when on the surface, and even operate in surf zones.

U.S. Submariners' Right Stuff

Discussions of warfighting prowess invoke crucial personal and institutional traits, including deep commitment, selfless sacrifice and unflinching daring in the face of danger. They cast uncommon initiative and coolly embracing significant risk as keys to remarkable success amidst the "fog of war".

While these characteristics have stood out in combat and other high risk environs – and we inherit a vivid legacy of examples from Submarine Force exploits – there is even more beneath the waterline.

The following article, authored by renowned psychologist and columnist Dr. Joyce Brothers, was published following the loss of USS THRESHER in 1963. In the wake of that nationally impacting tragedy, her probing exposé of the psyche of submariners was and remains a revealing set of observations.

The article speaks for itself, with remarkable insight regarding U.S. submariners' principal strengths, as applicable today as they were in 1963. A fundamental observation is that "... there is nothing dare devilish about [submariners]. They know themselves better than the next ..., [and] take every measure to make sure that safety, rather than danger, is maintained...". In the ever hostile environment of submergence in the open sea, nothing less than that circumspect mindset is warranted, to assure maximum understanding and successful exploitation of the full operating envelope when it must be brought to bear.

Dr. Brothers expressed several of our crucial traits in masculine terms and context (our Submarine Force was male-only, as were many other elements of our society in 1963). One may readily apply gender-common terms to her observations, though. Her observations remain enduringly insightful regarding the intellect, the team-working inclination and the perseverance of all who serve in today's Submarine Force, who in Dr. Brothers' words are "... willing[ ] to push themselves a little bit farther and not settle for an easier kind of existence."

Profile of a Submariner

by Dr. Joyce Brothers (1963)

The tragic loss of the submarine THRESHER and 129 men had a special kind of an impact on the nation.....a special kind of sadness, mixed with universal admiration for the men who choose this type of work.

One could not mention the THRESHER without observing, in the same breath how utterly final and alone the end is when a ship dies at the bottom of the sea....and what a remarkable specimen of man it must be who accepts such a risk.

Most of us might be moved to conclude, too, that a tragedy of this kind would have a damaging effect on the morale of the other men in the submarine service and tend to discourage future enlistment. Actually, there is no evidence that this is so.

What is it then, that lures men to careers in which they spend so much of their time in cramped quarters, under great psychological stress, with danger lurking all about them?

Togetherness is an overworked term, but in no other branch of our military service is it given such full meaning as in the "silent service". In an undersea craft, each man is totally dependent upon the skill of every other man in the crew, not only for top performance but for actual survival. Each knows that his very life depends on the others and because this is so, there is a bond among them that both challenges and comforts them.

All of this gives the submariner a special feeling of pride, because he is indeed a member of an elite corps. The risks, then, are an inspiration rather than a deterrent.

The challenge of masculinity is another factor which attracts men to serve on submarines. It certainly is a test of a man's prowess and power to know he can qualify for this highly selective service.

However, it should be emphasized that this desire to prove masculinity is not pathological, as it might be in certain dare-devil pursuits, such as driving a motorcycle through a flaming hoop. There is nothing daredevilish about motivations of the man who decides to dedicate his life to the submarine service. He does, indeed, take pride in demonstrating that he is quite a man, but he does not do so to practice a form of foolhardy brinkmanship, to see how close he can get to failure and still snatch victory from the jaws of defeat.

On the contrary, the aim in the submarine service is to battle danger, to minimize the risk, to take every measure to make certain that safety, rather than danger, is maintained at all times.

Are the men in the submarine service braver than those in other pursuits where the possibilty of a sudden tragedy is constant? The glib answer would be to say they are. It is more accurate, from a psychological point of view, to say they are not necessarily braver, but that they are men who have a little more insight into themselves and their capabilities.

They know themselves a little better than the next man. This has to be so with men who have a healthy reason to volunteer for a risk.

They are generally a cut healthier emotionally than others of the similar age and background because of their willingness to push themselves a little bit farther and not settle for an easier kind of existence. We all have tremendous capabilities but are rarely straining at the upper level of what we can do, these men are.

This country can be proud and grateful that so many of its sound, young, eager men care enough about their own stature in life and the welfare of their country to pool their skills and match them collectively against the power of the sea.

(This is a report made by Dr. Joyce Brothers after the loss of the USS THRESHER in 1963.)

The *Los Angeles*-class fast-attack submarine USS *Santa Fe* (SSN 763) arrived at HMAS Stirling, Australia for a scheduled port visit this February 2019. They quickly found ways to engage with the local community, like volunteering at Perth Zoo's Australian bushwalking area, relocating kangaroo feeding stations, mulching, and distributing new sand.

Photo courtesy U.S. Consulate Perth

Department of the Navy Announces New Education Initiatives

The Department of the Navy (DoN) released its Education for Seapower report Feb. 12, along with the Secretary of the Navy's action memorandum providing the way forward for the new education initiatives for the department.

The Education for Seapower study was a clean-sheet review of naval learning and focused on flagship institutions like the U.S. Naval Academy, Naval Postgraduate School, and Naval and Marine War Colleges, along with a fresh look at the relationships with civilian academic institutions and corporate learning structures.

Highlights from the memorandum include a new Secretary of the Navy staff assistant, Chief Learning Officer for naval education, intent to establish a Naval Community College with universal transcripts so enlisted Sailors and Marines can soon earn accredited associate's degrees in technology-rich fields, and a new Naval University System that retains the strengths of current educational institutions while aligning strategic intent in order to provide increased agility. While the DoN is enacting these changes, many initiatives within them will, over the next year, be evaluated for their efficacy before being fully implemented.

SailorsFirst

3 Things to Know About Navy College Program App Updates

The Navy College Program (NCP) mobile application's latest update, released Feb. 28.

The NCP app is primarily for active-duty members and is a key tool for educational service officers and career counselors. The app provides access to voluntary education planning tools; the Navy College Virtual Education Center (NCVEC) through phone, live chat, or help ticket; contact information on open overseas Navy College Offices; the MyEducation module; training videos; and additional resources.

Here are three NCP app updates every Sailor should know about:

1. **Look and Feel.** A new and improved design makes it easier to navigate the app, and even after adding new features, the app takes up less space on devices.

2. **MyEducation Access.** The MyEducation module and required training videos can now be accessed by entering in name, date of birth, and Department of Defense ID number instead of using a Common Access Card (CAC) for those times when Sailors cannot log on to a CAC-enabled computer.

3. **24-Hour Support During the Week.** Combining the NCVEC hours (7 a.m. to 7 p.m. EST) with the hours of 11 overseas Navy College Offices gives Sailors 24-hour support Monday through Friday. A new app feature connects Sailors with contact information for any open Navy College Office. Sailors can now also search frequently asked questions, another self-service tool right at a Sailor's fingertips with the app.

The app's tools are relevant to all Navy applicants, current Sailors, transitioning Sailors, and veterans. Featuring public content only, no authentication or authorization is required.

Users can download the app from the iTunes and Google Play online stores at no cost. To find the free NCP app, search "Navy College" or "NCP" in app stores or in your web browser.

For more information on Navy Voluntary Education, visit the NCP website at https://www.navycollege.navy.mil, and check out the Navy College Chatbot and online VOLED Assistance Center. Follow Navy VOLED on Facebook at https://www.facebook.com/NavyVoluntaryEducation/ for the latest news and updates.

The Navy College Program App was developed by the Navy's Sea Warrior Program (PMW 240) which assists Sailors with their manpower, personnel, training and education needs. The NCP app is part of a family of official Navy apps that can be found by visiting the Navy App Locker at http://www.applocker.navy.mil. In addition to educational apps, Sailors will find apps on fitness, uniforms and financial planning.

Welcome Home!

Machinist's Mate Nuclear Second Class Kyle Parden greets his wife Shelby Parden and his three-year-old daughter, Lucella, with the traditional first hug during a homecoming celebration for the *Los Angeles*-class, fast-attack submarine USS *Pittsburgh* (SSN 720), on Naval Submarine Base New London in Groton, Conn.

Photo by Mass Communication Specialist 1st Class Steven Hoskins

SailorsFirst

Two-Piece, Flame-Resistant Organizational Clothing Reaches Next Step of Testing

U.S. Fleet Forces (USFF) Command will begin a second round of testing later this year on a two-piece organizational clothing variant that offers flame resistance and moves the Navy one step closer to delivering Sailors a safe, comfortable, no-cost alternative to the Improved Flame Resistant Variant (IFRV) coveralls, with the same travel flexibility as the Type III working uniform.

USFF conducted the initial wear test on two-piece variants from May through September of last year and collected feedback from nearly 200 wear-test participants across surface, aviation and submarine communities about everything from colors and design to comfort and options like buttons and hook-and-loop fasteners. The command also received feedback from more than 1,700 Sailors in an online survey about colors and design.

Fleet survey responses indicated that Sailors liked the functionality of the Type III but would like to see the design in traditional Navy uniform colors. More than 70 percent of E-6 and junior Sailors surveyed liked the navy blue blouse and trouser while a khaki version was the preference for chiefs and officers.

"Leaders are listening to the fleet when it comes to this design," said USFF Fleet Master Chief Rick O'Rawe, a wear-test participant. "We have an obligation to keep our Sailors safe in inherently dangerous environments, but we also want to be mindful of their time. This is going to be something that's safe, easy to maintain, and doesn't require half-masting of coveralls when it's hot or having to change clothes every time you leave the ship. Never again should we have to pass the words 'all hands shift into the uniform for entering port or getting underway.'"

The updated design, which won't require Sailors to sew on components, will be tested by 100 officers and enlisted Sailors to see how well it performs from wash-to-wear without ironing and how it holds up to laundering. The two-piece variant will allow for de-blousing in extreme climates and challenging work environments. An undershirt will continue to be tested with a flame-resistant, moisture-wicking fabric in black.

"I have received so much feedback just from wearing the two-piece around the command every day," said Yeoman 1st Class Kelly Pyron, a wear-test participant assigned to USFF. "The best part is that we'll be able to transit from the ship and run errands in the two-piece; having one standard underway and in-port across the board will be much more convenient. I am excited to see the wear test moving into the next phase of evaluation."

Once approved, the new prototype will serve as an alternative to the IFRV coverall for operational commands. The coverall may continue to be the prescribed clothing item for some Sailors in applicable work environments.

Pyron expressed, "If a clothing item, that I will not have to buy, can make my life easier while keeping me safe, I'm all for it."

Sailors from the USS *Missouri* (SSN 780) and USS *Jefferson City* (SSN 759) were honored to spend some time with Missouri Lt. Gov. Mike Kehoe and Jefferson City Mayor Carrie Tergin Jan. 2019. The bonds between the submarines and their namesake cities continues to be strong.

Expanded Access to Career Waypoint Available Through BOL

Command Career Counselors with access to Career Waypoints (C-WAY) may now submit applications for their Sailors' re-enlistments, component transfers, changes of rate, and separation intentions via C-WAY, which is now hosted on Bupers Online (BOL), the Navy announced Feb. 20.

This system update is a step toward providing access to all Sailors, said Capt. Dave Whitehead, the director of Military Community Management, Bureau of Navy Personnel.

The C-WAY system is a corporate Information Technology system that provides a mechanism for matching personnel inventory to requirements with the best performing Sailors.

SSSA will provide Sailors the opportunity to access the career exploration module - for instance, to explore rating opportunities for Professional Apprenticeship Career Track (PACT) Sailors to verify qualifications for designation.

For rated Sailors, the career exploration module can identify alternative rating opportunities for which they qualify via rate conversion. SSSA is a critical bridge in the development of a Detailing Marketplace that enables a more transparent distribution system with Sailors having more insight and choices regarding their career options. The near-term design plan is for the seamless integration of C-WAY and CMS-ID functions into a single coherent career management tool.

For more information on C-WAY go to https://www.public.navy.mil/bupers-npc/career/careercounseling/Pages/C-WAY.aspx.

***UNDERSEA WARFARE* Magazine has created this section in recognition of the enlisted Submariner—but we want you to get involved in the success of this effort. We would like you to send us "Community Outreach," "Liberty" photos, and/or "Homecoming" photos of families being re-united as the crews return.**

Send your submissions to the Military Editor via email to: underseawarfare@hotmail.com

Changes of Command

COMSUBLANT
Rear Adm. Blake Converse relieved
Rear Adm. Daryl Caudle

Naval Undersea Warfare Center
Rear Adm. Scott Pappano relieved
Rear Adm. Moises DelToro

COMSUBGRU 9
Rear Adm. Douglas Perry relieved
Rear Adm. Blake Converse

COMSUBRON 1
Capt. Wesley Bringham relieved
Capt. Richard Seif

COMSUBRON 20
Capt. Craig Gummer relieved
Capt. Robert Wirth

Naval Submarine Base Kings Bay
Capt. Chester Parks relieved
Capt. Brian Lepine

NUWC Newport AUTEC
Cmdr. Michael Woodcock relieved
Cmdr. Craig Shillinger

Undersea Rescue Command
Cmdr. Joshua Powers relieved
Capt. Michael Eberlein

USS *Bremerton* (SSN 698)
Cmdr. Christopher Lindberg relieved
Cmdr. David Kaiser

USS *Henry M. Jackson* (SSBN 730) (B)
Cmdr. Nathan Luther relieved
Cmdr. John Frye

USS *Henry M. Jackson* (SSBN 730) (G)
Capt. Kevin Macy relieved
Cmdr. Matthew Freniere

PCU *Montana* (SSN 794)
Cmdr. Michael Delaney assumed command

USS *Montpelier* (SSN 765)
Cmdr. Rod Hodges relieved
Capt. Todd Moore

USS *Nebraska* (SSBN 739) (G)
Cmdr. Alexander Baerg relieved
Cmdr. Jake Wadsley

USS *Oklahoma City* (SSN 723)
Cmdr. Steve Lawrence relieved
Cmdr. Thomas P. O'Donnell

PCU *Oregon* (SSN 793)
Cmdr. Dan Patrick assumed command

USS *Topeka* (SSN 754)
Cmdr. Richard Salazar relieved
Cmdr. Steven Tarr

PCU *Vermont* (SSN 792)
Cmdr. Henry Roenke assumed command

USS *Emory S. Land* (AS 39)
Capt. Michael Luckett relieved
Capt. Douglas Bradley

USS *Frank Cable* (AS 40)
Capt. Jeff Bierley relieved
Capt. Jeff Farah

Qualified for Command

Lt. Cmdr. Keenan Coleman
USS *Indiana* (SSN 789)

Lt. Cmdr. Mark R. Gordon
UWDC TAG

Lt. Cmdr. Ryan Grundt
USS *Alabama* (SSBN 731) (G)

Lt. Brian Juskiewicz
USS *Toledo* (SSN 769)

Lt. Cmdr. Jason C. Kim
NLEC Newport RI

Lt. Cmdr. Timothy D. Markley
USS *Alabama* (SSBN 731) (B)

Lt. Cmdr. Jonathan S. Ovren
USS *Scranton* (SSN 756)

Lt. Cmdr. Paul G. Pavelin
USS *Hawaii* (SSN 776)

Lt. Cmdr. Miguel Recalde
USS *Michigan* (SSGN 727) (G)

Lt. Cmdr. Matthew Reising
USS *Tennessee* (SSBN 734) (G)

Lt. Cmdr. Michael A. Rose
USS *Newport News* (SSN 750)

Lt. James Santelli
USS *Oklahoma City* (SSN 723)

Lt. Cmdr. Eric Stinson
USS *John Warner* (SSN 785)

Lt. Cmdr. Chad T. Tella
NSTCP Pearl Harbor Hawaii

Lt. Cmdr. Keith P. Turnbull
COMSEVENTHFLEET

Lt. Christopher M. Whitley
SLC Groton Conn.

Qualified in Submarines

Lt. j.g. Leo G. Anderle
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Joseph L. Andricola
USS *Washington* (SSN 787)

Lt. j.g. Joseph V. Antworth
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Mary Baker
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Sarah L. Beadle
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Andrew Bermudez
USS *Florida* (SSGN 728) (G)

USS *South Dakota* Commissioned

Cmdr. Craig Litty, right, requests permission to place USS *South Dakota* (SSN 790) in commission during the commissioning ceremony. *South Dakota* is the U.S. Navy's 17th *Virginia*-Class attack submarine and the third ship named for the State of South Dakota.

Lt. j.g. John P. Brasek
USS *Boise* (SSN 764)

Lt. j.g. Grant M. Brining
USS *New Mexico* (SSN 779)

Lt. j.g. Zachary M. Brown
USS *Tennessee* (SSBN 734) (G)

Lt. Francesco Calabrese
USS *Florida* (SSGN 728) (B)

Lt. j.g. Daniel R. Camargo
USS *Asheville* (SSN 758)

Lt. j.g. Stephen M. Capella
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Thomas R. Carman
USS *Mississippi* (SSN 782)

Lt. j.g. Matthew T. Carothers
USS *West Virginia* (SSBN 736) (G)

Lt. j.g. John P. Connor
USS *Toledo* (SSN 769)

Lt. j.g. Robert A. Costa
USS *Alexandria* (SSN 757)

Lt. Samuel A. Cotey
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. j.g. Gregory B. Cotten
USS *Pasadena* (SSN 752)

Lt. j.g. Michael Crowther
USS *Ohio* (SSGN 726) (B)

Lt. Connor M. Davis
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. j.g. Andrew L. Delo
USS *Washington* (SSN 787)

Lt. j.g. Alan M. Deore
USS *Columbus* (SSN 762)

Lt. j.g. Charles Desio
USS *Hartford* (SSN 768)

Lt. j.g. Alexander J. Dunn
USS *Boise* (SSN 764)

Lt. j.g. Jeffrey T. Fienberg
USS *Wyoming* (SSBN 742)(B)

Lt. j.g. Seth S. Fireman
USS *Newport News* (SSN 750)

Lt. j.g. Ltjg David J. Flores
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. Steven Floyd
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. Chris R. Fussman
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. j.g. Benjamin J. Galito
USS *Louisville* (SSN 724)

Lt. j.g. Elliot R. George
USS *Helena* (SSN 725)

Lt. j.g. William R. Graves
USS *Tennessee* (SSBN 734) (B)

Lt. Jacob Griffin
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Connor Gudmundsson
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Dylan J. Haines
USS *Tennessee* (SSBN 734) (G)

Lt. Ethan Hodge
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Matthew Houston
USS *Nevada* (SSBN 733) (G)

Lt. j.g. Tate Jensen
USS *Mississippi* (SSN 782)

Lt. j.g. Skye E. Johnson
USS *Florida* (SSGN 728) (G)

Lt. j.g. James Kacergis
USS *Michigan* (SSGN 727) (B)

Lt. j.g. Kent C. Kammermeier
USS *Charlotte* (SSN 766)

Lt. j.g. Spencer A. Kitten
USS *Pasadena* (SSN 752)

Lt. j.g. Ryan Kolden
USS *New Mexico* (SSN 779)

Lt. j.g. Beau S. Langdon
USS *Hampton* (SSN 767)

Lt. j.g. Anthony D. Lewis
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Caleb J. Lintz
USS *Toledo* (SSN 769)

Lt. j.g. David Liu
USS *Scranton* (SSN 756)

Lt. j.g. Joshua Lizotte
USS *Springfield* (SSN 761)

Lt. j.g. Ryan Lynch
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. Brendan H. McCarthy
USS *Annapolis* (SSN 760)

Lt. j.g. Zachary S. McClurg
USS *Georgia* (SSGN 729) (B)

Lt. j.g. John McIntosh
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Douglas K. McKenna
USS *Alabama* (SSBN 731) (B)

Lt. j.g. Troy McKenzie
USS *North Carolina* (SSN 777)

Lt. j.g. William F. Misitano
USS *Jacksonville* (SSN 699)

Lt. Atticus Moll
USS *San Juan* (SSN 751)

Lt. j.g. Dustin Oberlander
USS *Kentucky* (SSBN 737) (G)

Lt. j.g. Conner R. Oneill
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Douglas J. Ott
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Marcus Padilla
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Joseph Palazzolo
USS *New Hampshire* (SSN 778)

Lt. j.g. David A. Parker
USS *Hampton* (SSN 767)

Lt. j.g. Kyle R. Parker
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Kyle R. Pawlowski
USS *Nevada* (SSBN 733) (B)

Lt. Colton Peterson
USS *Seawolf* (SSN 21)

Lt. j.g. Nicholas A. Pracht
USS *Kentucky* (SSBN 737) (G)

COMSUBPAC Winners of 2018 Battle Efficiency Competition Awards

COMSUBRON 1
USS *Mississippi* (SSN 782)

COMSUBDEVRON 5
USS *Connecticut* (SSN 22)

COMSUBRON 7
USS *Columbia* (SSN 771)

COMSUBRON 11
USS *Pasadena* (SSN 752)

COMSUBRON 15
USS *Oklahoma City* (SSN 723)

COMSUBRON 17
USS *Nevada* (SSBN 733) (B)

COMSUBRON 17
USS *Nevada* (SSBN 733) (G)

COMSUBRON 19
USS *Michigan* (SSGN 727) (B)

COMSUBRON 19
USS *Michigan* (SSGN 727) (G)

Special Category
Submarine Tender
USS *Frank Cable* (AS 40)

Special Category
ARCO (ARDM 5)

Special Category
Undersea Rescue Command

Special Category
Det UR&D

Lt. j.g. Walker Prieb
USS *Springfield* (SSN 761)

Lt. j.g. Timothy C. Qualls Jr.
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Zachery Rafter
USS *Florida* (SSGN 728) (G)

Lt. j.g. Justin R. Rhea
USS *Pennsylvania* (SSBN 735) (G)

Lt. j.g. Brandon J. Ricca
USS *California* (SSN 781)

Lt. j.g. Evelyn Rios
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Wesley Royston
USS *Seawolf* (SSN 21)

Lt. Kathleen M. Schaidle
USS *Texas* (SSN 775)

Lt. j.g. Joshua D. Shope
USS *California* (SSN 781)

Lt. j.g. Nicholas K. Sitter
USS *Alexandria* (SSN 757)

Lt. j.g. Bryan A. Smith
USS *Bremerton* (SSN 698)

Lt. j.g. Jeffery D. Smith
USS *Nebraska* (SSBN 739) (B)

Lt. j.g. Jacob Stevenback
USS *Alaska* (SSBN 732) (B)

Lt. j.g. Nathaniel J. Stone
USS *California* (SSN 781)

Lt. j.g. Frederick W. Tidwell III
USS *Maine* (SSBN 741) (B)

Lt. j.g. Tyler D. Todd
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Thomas F. Toohig
USS *Toledo* (SSN 769)

Lt. Charles O. Townsend
USS *Columbus* (SSN 762)

Lt. j.g. Jake Vanriper
USS *Ohio* (SSGN 726) (B)

Lt. j.g. Colton Vanthof
USS *Alaska* (SSBN 732) (B)

Lt. j.g. James S. Wagner
USS *Hawaii* (SSN 776)

Lt. j.g. Kyle T. Waldorf
USS *Tucson* (SSN 770)

Lt. j.g. Zachary Watt
USS *New Hampshire* (SSN 778)

Lt. j.g. Benjamin West
USS *Cheyenne* (SSN 773)

Lt. j.g. Brandon L. Williams
USS *Alaska* (SSBN 732) (G)

Lt. j.g. Harrison Willoughby
USS *Boise* (SSN 764)

Lt. j.g. Bryson Wilson
USS *Maryland* (SSBN 738) (B)

Lt. Kathleen Wilson
USS *Michigan* (SSGN 727) (B)

Qualified Nuclear Engineering Officer

Lt. j.g. Alyster Alcudia
USS *Connecticut* (SSN 22)

Lt. j.g. Nicholas Allen
USS *Albany* (SSN 753)

Lt. Payton Alsup
USS *New Mexico* (SSN 779)

Lt. j.g. Zachary Andersson
USS *John Warner* (SSN 785)

Lt. j.g. Rayne Bachman
USS *Minnesota* (SSN 783)

Lt. j.g. Mary Baker
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Kimokeo Barabin
USS *Columbia* (SSN 771)

Lt. j.g. Sarah Beadle
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Cecil Benner
USS *West Virginia* (SSBN 736) (B)

Lt. James Bishop
USS *California* (SSN 781)

Lt. j.g. George Blank
USS *Ohio* (SSGN 726) (B)

Lt. j.g. Daniel Booth
USS *Virginia* (SSN 774)

Lt. j.g. Grant Brining
USS *New Mexico* (SSN 779)

Lt. j.g. Zachary Brown
USS *Tennessee* (SSBN 734) (G)

Lt. Michael Brun
USS *Kentucky* (SSBN 737) (G)

Lt. j.g. Jonathan Buday
USS *Colorado* (SSN 788)

Lt. j.g. Kevin Burns
USS *Oklahoma City* (SSN 723)

Lt. James Byrne
USS *Alaska* (SSBN 732) (B)

Lt. Jeremy Cadiente
USS *Maryland* (SSBN 738) (B)

Lt. Francesco Calabrese
USS *Florida* (SSGN 728) (B)

Lt. j.g. Daniel Camargo
USS *Asheville* (SSN 758)

Lt. Tyler Canington
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Thomas Carman
USS *Mississippi* (SSN 782)

Lt. j.g. Matthew Carothers
USS *West Virginia* (SSBN 736) (G)

Lt. Jonathon Casey
USS *Key West* (SSN 722)

Lt. j.g. Patrick Casey
USS *Pittsburgh* (SSN 720)

Lt. j.g. Charles Castiglione
USS *San Juan* (SSN 751)

Lt. Theja Chadalawada
USS *Pasadena* (SSN 752)

Lt. j.g. John Chanatry
USS *Montpelier* (SSN 765)

Lt. j.g. Bradford Clemens
USS *Washington* (SSN 787)

Lt. j.g. Zachary Coleman
USS *Oklahoma City* (SSN 723)

Lt. j.g. Taylor Compton
USS *Minnesota* (SSN 783)

Lt. j.g. James Convery
USS *Indiana* (SSN 789)

Lt. j.g. Samuel Cotey
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. j.g. Jacob Crim
USS *Hawaii* (SSN 776)

Lt. j.g. Michael Crowther
USS *Ohio* (SSGN 726) (B)

Lt. Tracy Daniels
USS *San Francisco* (SSN 711)

Lt. Connor Davis
USS *Henry M. Jackson* (SSBN 730) (B)

Lt. Alexander Dellva
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. James Delosreyes
USS *New Hampshire* SSN 778)

Lt. j.g. Charles Desio
USS *Hartford* (SSN 768)

Lt. j.g. Joshua Devera
USS *Nevada* (SSBN 733) (G)

Lt. Andrew Dotson
USS *Pennsylvania* (SSBN 735) (G)

Lt. Jonathan Driesslein
USS *California* (SSN 781)

Lt. j.g. Matthew Dukleth
USS *Columbia* (SSN 771)

Lt. j.g. Alexander Dunn
USS *Boise* (SSN 764)

Lt. Timothy Dwyer
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. William Eisenhauer
USS *Alaska* (SSBN 732) (G)

Lt. j.g. Brett Evans
USS *Cheyenne* (SSN 773)

Lt. j.g. Jeffrey Feinberg
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Benjamin Field
USS *Asheville* (SSN 758)

Lt. Donald Finkes
USS *Ohio* (SSGN 726) (G)

Lt. j.g. David Flores
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. Steven Floyd
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Vincent Foschini
USS *Springfield* (SSN 761)

Lt. j.g. Justin Fratantuono
USS *Kentucky* (SSBN 737) (G)

Lt. James Frazier
USS *Pasadena* (SSN 752)

Lt. j.g. Emily Freese
USS *Georgia* (SSGN 729) (G)

Lt. j.g. John Frnka
USS *Albany* (SSN 753)

Lt. Joel Froehlich
USS *Oklahoma City* (SSN 723)

Lt. j.g. Joseph Galletdestaurin
USS *Maine* (SSBN 741) (G)

Lt. j.g. Christopher Garbellini
USS *Texas* (SSN 775)

Lt. j.g. Ethan Genco
USS *Key West* (SSN 722)

Lt. j.g. Elliot George
USS *Helena* (SSN 725)

Lt. j.g. Mark Getzy
USS *Missouri* (SSN 780)

Lt. Margaret Gilroy
USS *Michigan* (SSGN 727) (G)

Lt. j.g. Carson Goldman
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Juan Gomezverduzco
USS *Nevada* (SSBN 733) (G)

Lt. j.g. Justin Gould
USS *Montpelier* (SSN 765)

Lt. j.g. William Graves
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Alex Greene
USS *Hartford* (SSN 768)

Lt. Jacob Griffin
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Earl Gripton
USS *Newport News* (SSN 750)

Lt. j.g. Forrest Grissom
USS *Henry M. Jackson* (SSBN 730) (B)

COMSUBLANT Winners of 2018 Battle Efficiency Competition Awards

COMSUBRON 4
USS *North Dakota* (SSN 784)

COMSUBRON 6
USS *John Warner* (SSN 785)

COMSUBRON 12
USS *Providence* (SSN 719)

COMSUBRON 16
USS *Florida* (SSGN 728) (B)

COMSUBRON 20
USS *Alaska* (SSBN 732) (B)

COMSUBRON 20
USS *Alaska* (SSBN 732) (G)

Lt. j.g. Matthew Grote
USS *Mississippi* (SSN 782)

Lt. j.g. Connor Gudmundsson
USS *Ohio* (SSGN 726) (G)

Lt. Andrew Haggerty
USS *Topeka* (SSN 754)

Lt. j.g. Dylan Haines
USS *Tennessee* (SSBN 734) (G)

Lt. Brendan Hanlon
USS *Santa Fe* (SSN 763)

Lt. Ganesh Harihara
USS *Providence* (SSN 719)

Lt. William Harris
USS *Jimmy Carter* (SSN 23)

Lt. j.g. Andrew Hartman
USS *Topeka* (SSN 754)

Lt. j.g. Alexander Hayden
USS *North Dakota* (SSN 784)

Lt. j.g. John Haynes
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Evan Hendler
USS *Alaska* (SSBN 732) (B)

Lt. j.g. Bradley Hendrickson
USS *Louisiana* (SSBN 743) (B)

Lt. Edward Hennings
USS *Chicago* (SSN 721)

Lt. Zachary Hensley
US *Nebraska* (SSBN 739) (G)

Lt. j.g. Ryan Hill
USS *Rhode Island* (SSBN 740) (G)

Lt. j.g. Landon Hillyard
USS *Pennsylvania* (SSBN 735) (G)

Lt. Ethan Hodge
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Nicholas Hoffman
USS *Hawaii* (SSN 776)

Lt. j.g. Riley Hoffmann
USS *Pennsylvania* (SSN 735) (B)

Lt. j.g. Matthew Homeier
USS *Key West* (SSN 722)

Lt. Christopher House
USS *San Juan* (SSN 751)

Lt. j.g. Tate Jensen
USS *Mississippi* (SSN 782)

Lt. j.g. Colin Jester
USS *Rhode Island* (SSBN 740) (B)

Lt. j.g. Stephen Johnson
PCU *Delaware* (SSN 791)

Lt. j.g. Andrew Jones
USS *Springfield* (SSN 761)

Lt. Mitchell Kallek
USS *Charlotte* (SSN 766)

Lt. j.g. Kent Kammermeier
USS *Charlotte* (SSN 766)

Lt. j.g. Patrick Kauffold
USS *Charlotte* (SSN 766)

Lt. j.g. Lee Kaufman
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Stephen Keehan
USS *Jefferson City* (SSN 759)

Lt. j.g. Daniel King
USS *Pittsburgh* (SSN 720)

Lt. j.g. Ryan Kolden
USS *New Mexico* (SSN 779)

Lt. j.g. Dustin Kuchenbecker
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. Travis Lawrence
USS *Columbia* (SSN 771)

Lt. j.g. Megan Lewis
USS *Maine* (SSBN 741) (G)

Lt. j.g. Nicholas Loberg
USS *Maryland* (SSBN 738) (B)

Lt. j.g. Hamzah Lodge
USS *Pennsylvania* (SSBN 735) (B)

Lt. j.g. Kevin Logar
USS *Annapolis* (SSN 760)

Lt. j.g. Ryan Lynch
USS *Wyoming* (SSBN 742) (G)

Lt. j.g. Zachary Lynn
USS *Boise* (SSN 764)

Lt. j.g. Duncan Mamer
USS *Nebraska* (SSBN 739) (G)

Lt. Courtney Martin
USS *Georgia* (SSGN 729) (G)

Lt. j.g. Anthony Matus
USS *Colorado* (SSN 788)

Lt. j.g. Lawrence McCarren
USS *Rhode Island* (SSBN 740) (B)

Lt. j.g. Brendan McCarthy
USS *Annapolis* (SSN 760)

Lt. j.g. Zachary McClurg
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Patrick McDonald
USS *Pennsylvania* (SSBN 735) (B)

Lt. j.g. John McIntosh
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Troy McKenzie
USS *North Carolina* (SSN 777)

Lt. j.g. Cody McNeil
USS *Montpelier* (SSN 765)

Lt. j.g. William McShane
USS *Bremerton* (SSN 698)

Lt. j.g. Julie Miller
USS *Georgia* (SSGN 729) (G)

Lt. j.g. William Misitano
USS *Jacksonville* (SSN 699)

Lt. j.g. Antonio Mistron
USS *New Mexico* (SSN 779)

Lt. Timothy Moore
USS *Toledo* (SSN 769)

Lt. j.g. Nicholas Moyle
USS *Olympia* (SSN 717)

Lt. j.g. Devin Mulcahy
USS *Boise* (SSN 764)

Lt. j.g. Louis Nabors
USS *Toledo* (SSN 769)

Lt. Rebecca Navarre
USS *Michigan* (SSGN 727) (G)

Lt. j.g. Kha Nguyen
USS *Jacksonville* (SSN 699)

Lt. j.g. Daniel Norris
USS *Alaska* (SSBN 732) (G)

Lt. j.g. John Nugent
USS *Helena* (SSN 725)

Lt. j.g. Kevin O'Dowd
USS *West Virginia* (SSBN 736) (B)

Lt. j.g. Conner O'Neill
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Michael Oswald
USS *New Mexico* (SSN 779)

Lt. j.g. David Parker
USS *Hampton* (SSN 767)

Lt. j.g. Kyle Parker
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Collin Parry
USS *Pasadena* (SSN 752)

Lt. j.g. Douglas Patson
USS *Virginia* (SSN 774)

Lt. j.g. Kyle Pawlowski
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Justin Peabody
USS *Helena* (SSN 725)

Lt. j.g. Jeffrey Pearson
USS *Tennessee* (SSBN 734) (B)

Lt. Colton Peterson
USS *Seawolf* (SSN 21)

Lt. Stephanie Pilon
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Zachary Rafter
USS *Florida* (SSGN 728) (G)

Lt. j.g. Victoria Rand
USS *Michigan* (SSGN 727) (G)

Lt. Skyler Raybin
USS *California* (SSN 781)

Lt. j.g. Karl Rebholz
USS *Jacksonville* (SSN 699)

Lt. Jordan Rettie
USS *Newport News* (SSN 750)

Lt. j.g. Justin Rhea
USS *Pennsylvania* (SSBN 735) (G)

Lt. j.g. Brandon Ricca
USS *California* (SSN 781)

Lt. St. John Richardson
USS *Albany* (SSN 753)

Lt. j.g. Evelyn Rios
USS *Georgia* (SSGN 729) (B)

Lt. j.g. Danielle Rowan
USS *Florida* (SSGN 728) (G)

Lt. j.g. Wesley Royston
USS *Seawolf* (SSN 21)

Lt. Wesley Rudy
USS *Louisiana* (SSBN 743) (B)

Lt. j.g. Sebastian Saldivar
USS *Rhode Island* (SSBN 740) (B)

Lt. Kathleen Schaidle
USS *Texas* (SSN 775)

Lt. j.g. Christopher Scott
USS *Pennsylvania* (SSBN 735) (G)

Lt. j.g. Jarod Scott
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. Ethan Scully
USS *North Dakota* (SSN 784)

Lt. j.g. Brian Shannon
USS *Indiana* (SSN 789)

Lt. j.g. Alexander Shimizu
USS *Oklahoma City* (SSN 723)

Lt. j.g. Thomas Sledge
USS *Nebraska* (SSBN 739) (B)

Lt. Nicholas Sloot
USS *Hampton* (SSN 767)

Lt. j.g. Bridger Smith
USS *Nebraska* (SSBN 739) (B)

Lt. j.g. Jeffery Smith
USS *Nebraska* (SSBN 739) (B)

Lt. j.g. Steven Smith
USS *Alabama* (SSBN 731) (B)

Lt. Matthew Solomon
USS *Missouri* (SSN 780)

Lt. Michael Spotts
USS *Colorado* (SSN 788)

Lt. j.g. Adam Stowe
USS *Virginia* (SSN 774)

Lt. Ian Sugg
USS *Columbia* (SSN 771)

Lt. Dustin Swanson
USS *Pasadena* (SSN 752)

Lt. j.g. Karl Swanson
USS *Pennsylvania* (SSBN 735) (G)

Lt. j.g. Christopher Szymanski
USS *Louisville* (SSN 724)

Lt. Geoff Taylor
USS *Alabama* (SSBN 731) (G)

Lt. j.g. Spencer Thompson
USS *Indiana* (SSN 789)

Lt. j.g. Frederick Tidwell
USS *Maine* (SSBN 741) (B)

Lt. Emanuel Towns
USS *Annapolis* (SSN 760)

Lt. Charles Townsend
USS *Columbus* (SSN 762)

Lt. j.g. William Trettin
USS *Maine* (SSBN 741) (B)

Lt. j.g. Daniel Tucker
USS *Illinois* (SSN 786)

Lt. j.g. George Turner
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Grant Valenstein
USS *Minnesota* (SSN 783)

Lt. j.g. Nathanial Vallancey-Martinson
USS *Chicago* (SSN 721)

Lt. j.g. Jake Vaniper
USS *Ohio* (SSGN 726) (B)

Lt. j.g. Colton Vanthof
USS *Alaska* (SSBN 732) (B)

Lt. Kyle Vassallo
USS *Columbia* (SSN 771)

Lt. j.g. Brant Verhulst
USS *John Warner* (SSN 785)

Lt. Derek Vondisterlo
USS *Springfield* (SSN 761)

Lt. Christopher Vongunten
USS *California* (SSN 781)

Lt. j.g. James Wagner
USS *Hawaii* (SSN 776)

Lt. Rohika Wagner
USS *Greeneville* (SSN 772)

Lt. j.g. Kyle Waldorf
USS *Tucson* (SSN 770)

Lt. Nicholas Wendrych
USS *Bremerton* (SSN 698)

Lt. j.g. Nicholas Westmoreland
USS *Hawaii* (SSN 776)

Lt. j.g. Matthew Williams
PCU *Delaware* (SSN 791)

Lt. j.g. Harrison Willoughby
USS *Boise* (SSN 764)

Lt. j.g. Bryson Wilson
USS *Maryland* (SSBN 738) (B)

Lt. William Woltman
USS *Michigan* (SSGN 727) (B)

Lt. j.g. Eric Young
PCU *Delaware* (SSN 791)

Lt. Roy Zarefoss
USS *Columbia* (SSN 771)

Get in on the 20th Annual National Submarine League Photo Contest

UNDERSEA WARFARE Magazine is looking for this year's top submarine-related photos for the 20th Annual Photo Contest. The best of the best will be published in the Fall 2019 edition.

Established in 1999 and co-sponsored by the Naval Submarine League and the Director, Submarine Warfare (OPNAV N97), we recognize four winning photos each year with the following cash awards: 1st Place: $500, 2nd Place: $250, 3rd Place: $200 and Honorable Mention: $50.

Note: Entries must be received by September 1, 2018. However time permitting, photos received shortly after the deadline will be considered.

Digital submissions must be at least 5" by 7", at least 300 dots-per-inch (dpi), and previously unpublished in printed media. Each person is limited to five submissions, which can be sent as JPG or other digital photo format to the email address below. Printed photos may also be mailed to the following address:

Military Editor
Undersea Warfare CNO
2000 Navy Pentagon
Washington, D.C. 20350-2000

Or email to: underseawarfare@hotmail.com

Photo above is the 1st place winner of the 19th Annual Naval Submarine League Photo Contest. USS Olympia Swim Call by FTCS (SS) Vien Nguyen

WW II Submarine Battle Flags

USS *Skate* (SS 305)

Skate began her first war patrol in September 1943 performing lifeguard duties near Wake. She was strafed by enemy aircraft, under shore bombardment, and dive bombed, but rescued six downed pilots. These are indicated in the bottom left of her flag.

The second and third war patrols took *Skate* to Truk, where she damaged an aircraft carrier and sank a cargo ship. In a hasty torpedo attack, *Skate* badly damaged the battleship *Yamato*. *Skate*'s crew later spotted a light cruiser with two escorts, and she sank the cruiser, *Agano*.

During *Skate*'s fourth war patrol, in the Bonin Islands, she damaged one cargo ship and surfaced for a gun attack on a sampan. The gun attack is represented at the bottom center of the flag. *Skate*'s crew took aboard three Japanese survivors and treated two of them for injuries.

The fifth war patrol saw *Skate* patrolling near the Kuril Islands. She intercepted a convoy of two cargo ships and three escorting destroyers. Her crew sank one destroyer and damaged the larger cargo ship. She later sank a small freighter, taking aboard two survivors.

On her sixth war patrol, *Skate* sank a cargo ship near the Ryukyu Islands and, on her seventh, headed for the Sea of Japan. She spotted a submarine returning to port and sank *I-121* with two torpedoes. *Skate*'s crew discovered several cargo ships hiding in a cove. *Skate* entered the cove and fired all six bow tubes, hitting three ships and sinking one. After turning to leave, she fired three stern tubes, damaging or sinking two more ships. She later sank another cargo ship, taking aboard three survivors for a total of eight POWs, two more than indicated on her flag.

Not represented on *Skate*'s flag are the eight battle stars for her WWII service.